UNIVERSITY OF THE WITWATERSRAND ,SCHOOL OF
ARCHITECTURE AND PLANNING

trans-form-medium

The transformation of light, space and process through the medium of glass.

A glass recycling hub for Waste Reclaimers in Newtown

Murray Hardman

12/12/2014

This document is submitted in partial fulfillment for the degree:
Master of Architecture [Professional]
at the University of the Witwatersrand, Johannesburg, South Africa,
in the year 2014. Supervised by Professor Diaan van der Westhuizen

DECLARATION

I, Murray Richard Hardman, student number 744629, am a student registered for the course Master of Architecture [Professional] in the year 2014. I hereby declare the following:

I am aware that plagiarism [the use of someone else's work without permission and/or without acknowledging the original sources] is wrong. I confirm that the work submitted for assessment for the above course is my own unaided work except where I have stated explicitly otherwise. I have followed the required conventions in referencing thoughts, ideas, and visual materials of others. For this purpose, I have referred to the Graduate School of Engineering and the Built Environment style guide. I understand that the University of the Witwatersrand may take disciplinary action against me if there is a belief that this is not my unaided work or that I have failed to acknowledge the source of the ideas or words in my own work.

Murray Richard Hardman
12 December 2014

ACKNOWLEDGMENTS

I would first like to acknowledge my Lord God for giving me the inner strength to complete this thesis. To my friends and family thank you for all the support and encouragement throughout the year.

Special thanks to:

- Lindsay Hardman, I would never have been able to get through this without you!
- Diaan van der Westhuizen for all your commitment and guidance thoughout the year. Thank you for pushing me to challenge myself and achieve my best.
- Mohammed Munchi and Jonathan Noble for getting me back on track.
- My parents for their unfailing support.
- Eben Louw and Trovano Technologies; Gugu Mkhize and the EISD; Enrique and City Zama Waste; Kea Nkitseng and the Glass Recycling Company; The Joburg Waste Reclaimers Committee; Lucky Ramatshimbila and Consol and all those who assisted me in providing information and guidance for this project.
- The Waste Reclaimers and the inspiration they provided.

ABSTRACT

High levels of unemployment are a reality in many of the urban areas of South Africa. Poverty and hardship compel many of the unemployed to venture into the urban informal economy in order to survive. The South African government have found new ways of creating employment opportunities, one of which is within the recycling industry. There is an increased demand for minimizing mankind's environmental footprint. Glass is a material that has been used for centuries and has the ability to be recycled infinitely without losing its quality (Marson, n.d). This together with the need for glass amongst consumers and the endlessly recycling nature of glass makes glass recycling a significant sustainable measure in considering environmental impacts (2011, 2012 Annual Review: Glass Recycling Company). Despite these properties, glass continues to be an undervalued material that can utilize low technology in its recycling process.

This study aimed at investigating the formal and informal recycling economy within the city of Johannesburg by providing the opportunity for the Waste Reclaimers (Trolley Pushers) to be an integral part of the recycling process, specifically with glass. A further aim was to explore the tectonics of a factory to create a space where the Waste Reclaimers could gather, connect and engage with the product of glass. Lastly it aimed to provide a space where the general public could also engage in the product of glass recycling thereby creating awareness and promotion of recycling.

The project proposed a glass recycling factory where the process of glass recycling culminates with the production of glass. The site selected for this research is located within the industrial part of the Newtown precinct. This has become a central recycling hub for the Waste Reclaimers of Johannesburg as it links private recycling centres within the city. Newtown is an area of flux, marked by a history of industrial and political disruption. This area represents change and opportunity for growth and life. A space recycled and regenerated throughout the history of Johannesburg.

The reason for the choice of topic is that the evolution of recycling in Johannesburg has reached a point where municipalities need to acknowledge the informal sector as a valuable part of the recycling economy. The majority of the literature on recycling and the organization of the recycling process predominantly focuses on the collection of waste as means of job creation. An opportunity therefore presented itself to highlight the production, and craftsmanship of recyclable material.

To clarify and further place the Waste Reclaimers within the existing waste management system, the theory of Phenomenology has been explored. It will focus on the phenomenological term of “Lifeworld” which describes a way of life where the individual’s aspiration, perceptions, experiences, beliefs and behaviour forms a holistic unity towards a fulfilling, meaningful, existence (Seamon, 2012). This exploration will give insight to how this building will provide the Waste Reclaimer a sense of identification and orientation within this system of the recycling industry. In order to better understand the complexity of the existing waste management system, the theory of Systems has been explored focusing on the principal of an open system as a way of broadening the lifeworld of the Waste Reclaimers

Precedent studies of PFG Building Glass windscreen recovery facility; Zama City Waste; the comparison of factory tectonics between the Crystal Palace, Toledo Museum of Art Glass and the Crucible Glassblowing studio; the Glass Chapel and The Nelson-Atkins Museum of Art were used to inform the design. The network of the Waste Reclaimers was also documented in order to understand their routes and network across the city and the surrounding suburbs.

The impact of the design found that the proposed space created opportunities for pause and transformation using light, space and process. The idea of transformation is process. Process is represented by a linear path with adjacent spaces of function and support. These spaces will transform according to their activities and associated light qualities. These spaces will thus become the medium through which people and activities change.

CONTENTS

TO MY WIFE LINDSAY

01 |

INTRODUCTION

The following chapter will introduce the project and provide a background to contextualize the problem statement, the rationale of the research, the aims and how these will be achieved.

An argument for a Glass Recycling Factory involving the informal waste collectors.

There is demand for minimizing mankind's environmental footprint. Glass is a material that has been used for centuries and has the ability to be recycled infinitely without loosing its quality (Marson, n.d). This together with the need for glass amongst consumers and the endlessly recycling nature of glass makes glass recycling a significant sustainable measure in considering environmental impacts (2011, 2012 Annual Review: Glass Recycling Company). The growth in recycling continues but the rate of growth has lowered in recent years, making recycling a key focus both within South Africa and internationally (2011, 2012 Annual Review: Glass Recycling Company). The CEO of the Glass Recycling Company reported that within the 2011/2012 year, the glass recycling rate in South Africa reached 40.1% and the number of active glass recycling entrepreneurs increased to 502. The increasing recycling rates in South Africa are of significance especially since there was no enforced legislature of recycling to encourage recycling as is the case in the United Kingdom. The legislature of enforced recycling is however in South Africa's pipeline. These facts confirm that South Africa has started integrating glass recycling as a sustainable practice (CEO 2011, 2012 Annual Review: Glass Recycling Company).

Johannesburg is located in the province of Gauteng within Sub-Saharan Africa. It is a city of stark contrasts – between those who enjoy the highest standard of living, and those who struggle to make ends meet (Tau, 2011). After 20 years of democracy South Africa remains confronted by a triple challenge of poverty, inequality and unemployment (Statistics South Africa, 2014). Poverty and hardship caused by unemployment force many participants in the labour market to venture into the urban informal economy in order to survive (Schenck, 2011).

The high unemployment rate and associated poverty rates have forced the South African government to think of new ways of creating new employment opportunities (Viljoen, 2012). The Department of Trade and Industry (DTI) identified job creation opportunities in the recycling industry, particularly with regard to the collection and sorting of waste (Goldblatt, 2009). This study provides a framework to enhance the potential of entrepreneurship and skills development within the recycling industry. The majority of the literature on recycling and the organization of the recycling process predominantly focuses on the collection of waste as means of job creation. An opportunity therefore presents itself to highlight the production, and craftsmanship of recyclable material. This research highlights the possibilities for new forms of job creation through glass recycling and manufacturing.

Figure 1.1 - Glass Recycling (Tradesy, 2014)

Figure 1.2 - Waste Reclaimer

Waste management in Johannesburg comprises of a formal and informal sector. The formal sector is made up of the municipality and private waste management companies including organisations such as The Glass Recycling Company who promote the recycling of glass. The Informal sector comprises of self-employed, Waste Reclaimers, who work either on the streets or at landfill sites.

There are no barriers to entering the waste collection industry, and therefore waste collection has become a survival strategy for many poor people (Langenhoven, 2007). Waste Reclaimers are independent, small-scale entrepreneurs who collect the waste off the street in both residential and industrial areas. They have become both a visible feature and an integral part of the urban context. [1]

This thesis aims to investigate the current waste recycling system within the city of Johannesburg. It will explore how this system can be enhanced by the integration of the formal and informal recycling sectors, by providing the opportunity for the Waste Reclaimers to be an integral part of the process of recycling. This will be achieved through the recycling of glass waste and the production of glass products.

The city of Johannesburg has a high consumer culture resulting in large amounts of waste which can be recycled with relatively low technology. The Waste Reclaimers create a network of activity and movement across the city. Through this activity of movement, they create a living. The proposed space will provide a place where the Waste Reclaimers will be able to engage in the material that they collect. The research aims to provide the Waste Reclaimers with the opportunity to become a part of the entire process of recycling specifically with the product of glass. Through this active interaction with the entire process of recycling glass, it will provide them with opportunities for higher levels of employment, skills development and creating enhanced work opportunities.

A further aim is to provide a space that challenges the notion of an industrial process being confined and restricted to an “industrial shed” stripped bare to its functional needs. It challenges the idea that people within the industrial process are atomized units engaged in a single specialized skill set. It aims to create a space that reveals and showcases the beauty of an industrial process and the art of making. This will also assist in creating public awareness of the recycling industry and increasing volumes of recyclable material. This proposed space will create an environment to expand the possibilities of the material of glass and its different processes. Creating an environment that nurtures transformation of both participant and medium.

The design process explores the concept of transformation through the medium of glass. The idea of transformation is process. Process is represented by a linear path with adjacent spaces of function and support. These spaces will transform according to their activities and associated light qualities. These spaces will thus become the medium through which people and activities change.

The research also aims to explore the concept of light. When light passes through a translucent medium, it pauses before changing direction. Depending on the medium it takes on a different characters and a different role. It pauses and changes just as people throughout the day when they participate in different activities. The proposed space creates opportunities for pause and change using light, space and process.

To clarify and further place the Waste Reclaimers within the existing waste management system the theory of phenomenology has been explored. It will focus on the phenomenological term of “Lifeworld”, which describes a way of life where the individual’s aspiration, perceptions, experiences, beliefs and behaviors forms a holistic unity towards a fulfilling, meaningful, existence. (Seamon, 2012). This exploration will give insight to how this building will provide the Waste Reclaimers a sense of identification and orientation within this system of the recycling industry. In order to better understand the complexity of the existing waste management system, the theory of systems has been explored focusing on the principal of an open system as a way of boarding the lifeworld of the Waste Reclaimers. An open system is defined as a system that is constantly exchanging energy and matter with its external environment in order to maintain its structures (Salat, 2014).

The proposed programme is to design a glass factory where the process of glass recycling and the production of glass culminate to create a context for the transformation of both participant and medium. Various precedents will be examined to understand the functional requirements of the facility. A comparison of precedents will be applied in order to explore the idea of showcasing an industrial process within an appropriate built form. This showcasing will also raise awareness of glass recycling and to educate the public about recycling.

A network of a selected group of Waste Reclaimers will also be documented in order to understand their vast network and routes. The site selected for the proposed building is located on the corner of Quinn Street and Barney Simon Street which is located in the industrial part Newtown precinct, Johannesburg. Newtown presents a unique awareness into the development of Johannesburg and modern South Africa as well as the important social, historical, political, industrial, artistic and cultural movements that have come to be associated with Johannesburg’s transformation from a Victorian mining camp to one of the world’s significant urban hubs. Newtown is also an example of how industrial and political forces disrupted and destroyed poorer communities in the name of “urban regeneration” whilst serving the apartheid regime’s interests. However, this area is transforming once again and it has become a place of opportunity for the Waste Reclaimers as it is central to the various recycling centers around Johannesburg.

02 |

SOCIAL-ECONOMIC & PHYSICAL CONTEXT

Newtown is an area marked by a history of industrial and political disruption. This area represents change and opportunity growth and life. A space recycled and regenerated throughout the history of Johannesburg plagued with moments of flux and pause in its growth and development.

Socio-Economic Context The Recycling Network as a medium for change

Waste can be defined as any material that is considered to be of no further use to the owner (Viljoen, J et al, 2012). However, most discarded waste can be reused or recycled. What may be of no further use to one person, who regards it as waste to be dumped, may be of use to the next person whom it provides a livelihood (Viljoen, J.M.M.; Schenck, C.J.; Blaauw,P.F., 2012).

In a context of high unemployment and poverty there is an increasing pressure to stimulate growth, develop an efficient economy and achieve socioeconomic gains (Goldblatt, 2009). In this context it is particularly important to assess the potential of the waste sector to meet economic policy objectives while ensuring that environmental objectives are met. Although the recycling process is capital intensive, "recycling itself will never be a major job creation source, but waste material collection and sorting, and job creation via the development of new enterprises creating alternative products from waste materials is full of potential" (Lowitt, 2008:12).

Although parts of the recycling industry are capital intensive, the waste sector is conducive to operational activity, which supports the employment of semi-skilled and unskilled workers (Goldblatt, 2009). Waste collection is highly labour intensive in South Africa and the recycling industry has the potential to contribute jobs in terms of materials collection and sorting of waste (Goldblatt, 2009). Indirect job opportunities, offers employment for waste collectors such as trolley pushers [(1)], landfill pickers [(2)], those who sell to buy-back centres [(3)] as well as those who collect from drop-off centres (Lowitt, 2008). Currently the recycling and manufacturing of glass is achieved through large scale manufacturing [(4)] however there is not enough emphasis put on small scale manufacturing [(5)] of glass to produce specialized product (Refer to figure 2.3).

The recycling industry is volatile to fluctuations in price changes for recyclables that can be a constraining factor for small businesses and individuals operating in the industry. The informal waste collectors are particularly vulnerable to these volatile fluctuations as they rely solely on the collection of recyclable waste. Therefore to incorporate them into to larger system where they not only collect but have the opportunity to manufacture product from the recyclable waste that they collect. This will make them less vulnerable to the price fluctuations within the recycling industry.

"job creation via the development of new enterprises creating alternative products from waste materials is full of potential" (Lowitt, 2008:12).

1.

Fig 2.1 - Waste Reclaimer

Figure 2.2 - Glass Bottles

Figure 2.3: The Waste Management System (Matjokana et al., 2005)

Management Network for change

The Different Role Players

Waste management in Johannesburg comprises of a formal and informal sectors (refer to Figure 2.4). The formal sector is made up of the municipality and private waste management companies including organisations such as The Glass Company who promote the recycling of glass. The Informal sector comprises of self-employed, Waste Reclaimers, also known as trolley-pushers, who work either on the streets or at landfill sites.

Pikitup is an entirely State Owned Company (SOC) by the City of Johannesburg. It is responsible for the execution of the waste management mandate of the City as contained in the Constitution of South Africa (De Beer, 2013). The City collects 1,8 million tons of garbage each year, with approximately 244 200 tons reflected in the form of illegal dumping, and 1 779 tons collected as litter from the streets (City of Johannesburg Metropolitan Municipality, 2011). Eleven waste management depots are strategically located throughout the City, collecting refuse from approximately 1,2 million formal and informal dwellings. Pikitup manages four landfill sites namely Robinson Deep, Marie-Louise, Goudkoppies and Ennerdale (Beer, 2013). An aggregate of eight years of landfill space remains, but this varies considerably across the City's regions. The City's Strategic Roadmap aims for a 50 percent reduction in waste to landfill by 2012 and zero waste to landfill by 2022 (City of Johannesburg Metropolitan Municipality, 2011). Current volumes of reclaimed or recycled waste vary by waste form, Pikitup is currently diverting 11 percent of its waste (City of Johannesburg Metropolitan Municipality, 2011).

South Africa's waste management sector holds significant potential for employment creation in both the public and private sphere (Viljoen et. al, 2012). It has been identified that the sector currently represents a missed opportunity for the creation of decent and formal employment opportunities. (Viljoen et al., 2012). Waste provides income generation opportunities for thousands of people both in the formal and in the informal economy.

Self-employed, Waste Reclaimers work either on the streets or at landfill sites. They recover items that are of value, sorting them and selling them on to buy-back-centres.

These buy back centres will then sell the recyclable waste to end users, these being paper mills, plastics companies and metal or glass smelters who then produce product to be sold (Viljoen et al., 2012). The Buy-Back Centres serve as the link between the formal (recycling companies) and the informal Waste Reclaimers both on the streets and the landfill sites (Viljoen et al, 2012). The Buy-Back Centres play a crucial role in facilitating the recycling potential of the informal-sector participants as the Buy-Back Centres are the agents to whom the Waste Reclaimers can sell their recyclable waste (Viljoen et al., 2012).

The role of the buy back centre has paved the way for an opportunity to enhance job creation through introducing Small Scale Recycling and Manufacturing companies as an additional link between the formal and informal sectors. This addition will also allow for social movement for the informal sector into the formal sector. Introducing this additional link it will diversify the current system and create further employment.

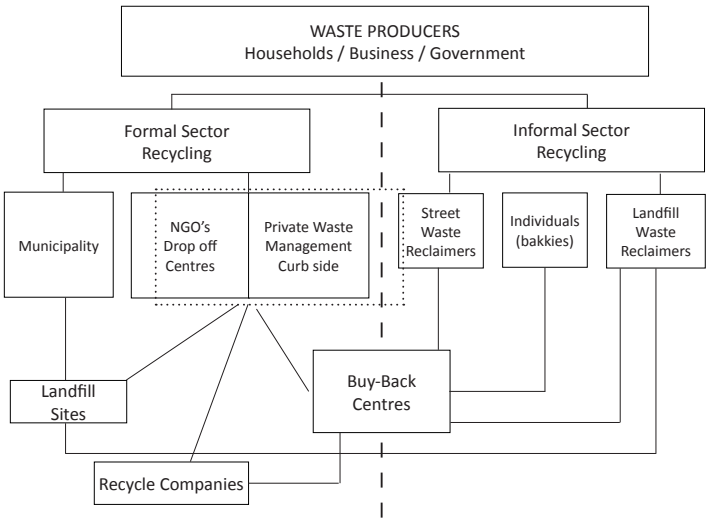


Figure 2.4: General overview of the waste recycling industry. (Viljoen et al, 2012)

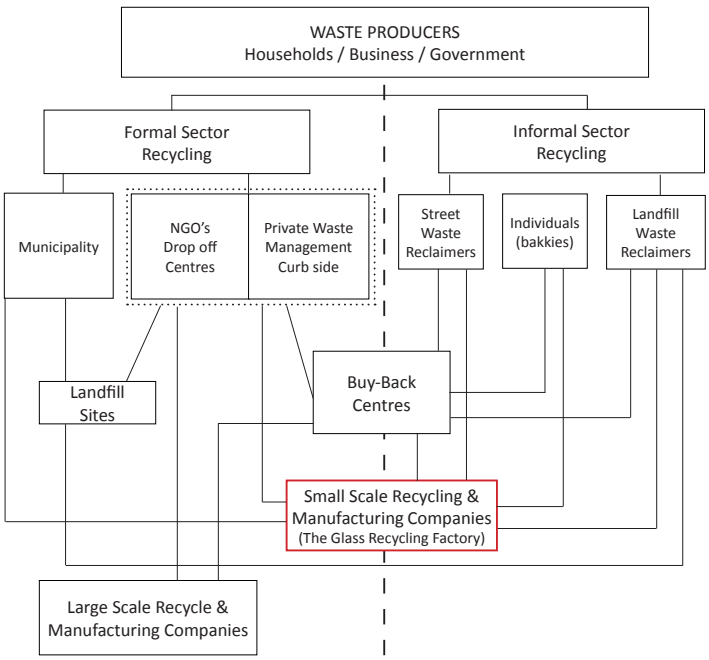


Figure 2.5: Proposed waste management system to allow social movement

Network Integration

Pikitup's overall strategy and therefore the cities strategy is to reduce waste sent to landfill by establishing a recycling economy through the separation of recyclable waste at its source. The city have adopted the Seperation at Source Progamme to enhance the cities strategy (De Beer, 2013). The additional benefits of the programme is to:

- Save transportation costs
- Ensure the full adoption of the waste hierarchy by the City of Johannesburg and its citizens. Compliance with waste recycling standards and guidelines of the National Environmental Management Act 107 of 1998.
- To comply with the provisions of the National Environmental Management: Waste Act 29 of 2008.

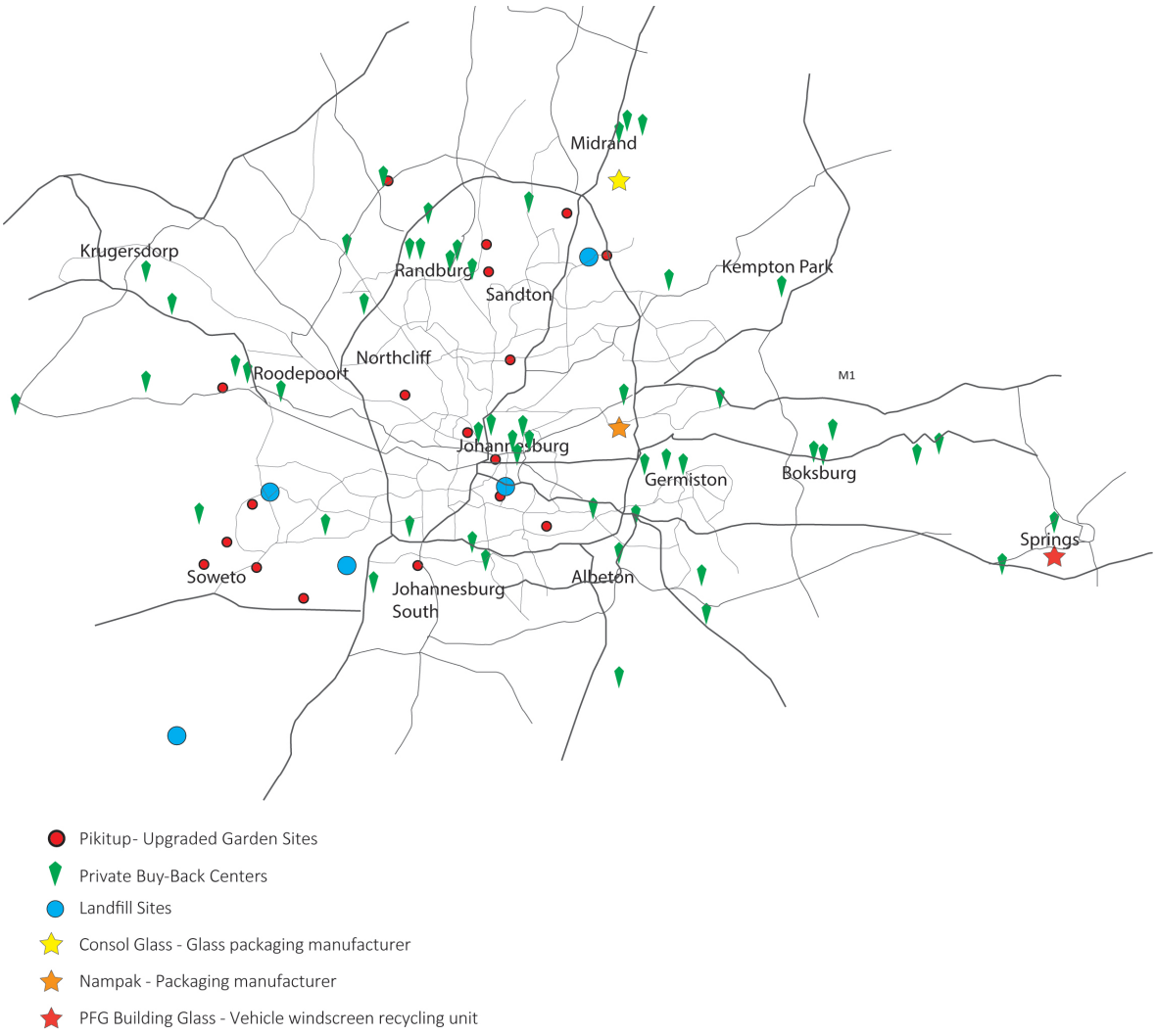
The secondary goals which will be achieved are job creation through formalization of Waste Reclaimers and the establishment of co-operatives. It also aimes to create greater capacity for waste recovery facilities and contribute to poverty alleviation (De Beer, 2013).

Pikitup have identified the following projects in which to assist them in achieving the above mentioned goals; these are namely to educate 950,000 households on the separation of recyclable waste at source by June 2016; to upgrade all garden sites to accept recyclable waste and identify recycling entrepreneurs to run these centres; to formalize the activities of the Waste Reclaimers in suburbs and landfills; support existing private recycling initiatives in the City; establish recycling programmes within schools and other institutions; and secure partnerships with private operators with in the recycling industry (De Beer, 2013).

The business model has taken into account the principle of "not one size fits all". The model distinguishes between the extension of the separation of recyclable waste at source to middle and high income areas, to low-income areas and informal settlements, supported by an integrated marketing, communication education and awareness drive (De Beer, 2013). Pikitup has proposed that the current waste removal approach incorporating separation at source be used in all middle and higher income areas. It has further proposed that the extension of separation at source to lower income areas and informal settlements focus on the capacitation of communities through the establishment of cooperatives/Non Profit Organisations (NPOs). Together with the construction and allocation of satellite sorting/buy back facilities to the cooperatives/NPOs taking into consideration the existing recycling facilities and buyback centres in the area (De Beer, 2013).

The model also provides for the establishment of Material Recovery Facilities (MRFs) to accommodate large volumes of recyclable waste needed to meet required targets. All the non-recyclables waste left over resulting from activities at the sorting facilities, garden sites and MRFs will then be collected and disposed of by Pikitup at one of its landfill sites (De Beer, 2013). De Beer (2013) explains that the key to the Separation at Source programme is the relationship between Pikitup and cooperatives or NPOs operating from sorting buyback centres constructed on council owned land. Pikitup will provide; Marketing, communication education and awareness. A Memorandum of Understanding and Lease Agreements, Recycling bags, Caged Vehicles for collecting waste, Buyback/sorting facilities and capacitation of cooperatives/NPOs and the collection and disposal of residual waste. The Cooperatives/ NPO will provide; distribution of bags, collection, sorting and selling of recyclables, Memorandum of Understanding and Lease Agreements,

Figure 2.6 Map of the Waste Management Role Players in Johannesburg



management of own staff, maintenance of facilities, monthly feedback on recyclables sold, monthly feedback on the participation in their allocated areas.

Pikitup manages 42 strategically located garden sites across the City (figure 2.6). It has proposed that these garden sites be included in the Separation at Source Programme adding great value to the Programme. Presently 22 garden sites accept recyclable waste separated at source leaving another 20 sites to be upgraded. All garden sites will be upgraded to accept recyclables and be marketed as centres where members of the public can take their recyclables. All new and existing garden sites will include sorting facilities and allocated a co-operative/entrepreneurs to manage recyclables delivered to the site. The deliverables and considerations in the execution of this project is to secure market for recycled waste and provide training for entrepreneurs/co-operatives. Upgrade all garden sites to centres to provide facilities to informal waste collectors to sort waste and leave their trolleys and other belongings overnight. This will enable the

reclaimers to return to their families daily.
The Environment and Infrastructure Services Department (EISD) of the City of Johannesburg have recognized the role played by the Waste Reclaimers (informal waste collectors) in terms of waste recovery and recycling. This includes waste minimization, waste diversion from landfill sites and assisting the municipality in reducing expenses on collecting waste that would otherwise have been transported by vehicles and disposed using public funds (Membe et al., 2013).

The EISD therefore acknowledged the need to empower the informal waste collectors and set up the following interventions:

- Capacitate the Waste Reclaimers on economic development issues.
- Educate the waste reclaimers on waste management issues and risks associated with environmental and health hazards.
- Educate the public about the role played by the Waste Reclaimers in waste management.
- Increase the Waste Reclaimers productivity and efficiency in waste recovery.
- Assist the Waste Reclaimers to become entrepreneurs and form co-operatives.

In order to achieve these interventions, "The Joburg Reclaimers empowerment plan" was developed in the financial year 2010/2011 (Membe et al., 2013). It comprised of two phases.

First phase:

- registration of the Joburg Reclaimers.
- Needs analysis workshop.
- Procurement of protective clothing.
- Investigation of the trolleys designs in order to achieve an ergonomically designed and user friendly trolley .

Second phase:

- Profile the 'Joburg reclaimers'
- Identify the training needs of the 'Joburg reclaimers'.
- Launch the pilot project in Region F and roll out city wide.
- Develop the guidelines for the operations of the 'Joburg reclaimers'.

The following is a summary of the implementation of the "The Joburg Reclaimers empowerment plan." (Membe et al., 2013) reports that in phase one a database of reclaimers was developed with a total of 716 Waste Reclaimers and 282 have been issued with permits (Figure 2.7). This registration process is undertaken through the assistance of Waste Reclaimer's committees, buy-back centres and landfill site managers. This process has provided the department with a platform of communication where the City can engage with waste management issues with the reclaimers through their committees and association.

The EISD is currently working with the Department of Economic development to assist the Waste Reclaimers in forming co-operatives (Membe et al., 2013). The department of Trade and Industry (DTI) defines a primary co-operative as an autonomous association of persons united voluntarily to meet their common economic, social and cultural needs and aspirations, through a jointly owned and democratically controlled enterprise. The EISD consider co-operatives a means to sustain the project and improve the lives of Reclaimers to actively participate in formal waste management activities. The department is currently assisting a registered co-operative of Waste reclaimers to develop a buy-back centre within the city centre of Johannesburg on council owned land to be operated by the co-operative. A needs analysis workshop was conducted in order to better understand the issues the reclaimers encounter and for the EISD to prioritize these

Figure 2.7 Waste Reclaimers Registration

Figure 2.8 - Waste Reclaimers with their newly designed trolleys.

Figure 2.9 - Waste Reclaimers Protective Clothing

needs (Membe et al., 2013).
Training was provided to the Waste Reclaimers in the form of a workshop focusing on business skills, recycling and its by-laws. This training provided the Waste Reclaimers an understanding of the type of work they do and how it connects with the waste management value chain of the city of Johannesburg (Membe et al., 2013). The registered Waste Reclaimers were given protective clothing consisting of a reflector vest, boots and two piece pants and jacket. (Figure 2.9)

The EISD further undertook to investigate the trolleys used for waste collection. They further developed a specification with the Waste Reclaimers committee and 50 newly designed trolleys were funded by PETCO (PET Plastic Recycling South Africa) (Figure 2.8)

A profile of the "Joburg Reclaimers" was documented to understand the challenges that the reclaimers face on a daily basis (Membe et al., 2013). The following was highlighted through the interview conducted:

- The reclaimers work is neither understood or appreciated
- Poor treatment by motorists
- Confiscation of their material by Johannesburg Metro Police
- They are exposed to harsh weather elements
- There is a lack of sorting and storage facilities (Figure 2.10)

A pilot project was launched in 2013 with the handover of newly design trolleys in March 2014. The development of guidelines for the operations of the Joburg reclaimers is currently being developed as the pilot project in Region F which will be a learning project that will assist in the development of this guideline for reclaimers.

Figure 2.10 - Storage of recyclable waste on vacant land

This thesis attempts to address the following interventions proposed by EISD:

- Assist the Waste Reclaimers to become entrepreneurs and form co-operatives.
- Educate the public about the role played by the Waste Reclaimers in waste management.
- Increase the Waste Reclaimers productivity and efficiency in waste recovery.

The initiative by Pikitup to upgrade its garden refuse sites to receive recyclables and offer the reclaimers an opportunity to run the operation of these sites, has provided an avenue to assist the waste reclaimers to form co-operatives and become entrepreneurs. However it has increased the amount of buy-back centres operating within Johannesburg (Figure2.6).

This thesis therefore suggests that the development of a small/medium scale glass recycling factory will further strengthen this intervention to assist the waste reclaimers become entrepreneurs and form co-operatives. (Figure 2.5).

Currently most of the glass that is recycled is sent to the major glass manufacturing plants of Consol and Nampak (Figure 2.6). The addition of the small/medium glass recycling factory will add value to the glass manufacturing sector by offering a handmade crafted product. It will provide the opportunity for the waste reclaimers to engage in the material of glass from collection to the manufacturing of glass product. This will generate social learning through the opportunity to view, experience and become evolved in the entire process of glass recycling. This will therefore increase skills development and provide a wider spectrum of opportunity for social and economic mobility.

The increase in glass recycling collection entrepreneurs reported by The Glass Recycling Company further indicates that there is a growing need for glass recycling initiatives within South Africa. The architecture of the Glass Recycling Factory together with its proposed public interface will provide a form of public awareness therefore educating the general public about recycling and creating awareness about the positive impact the waste reclaimers have had on the overall waste management system.

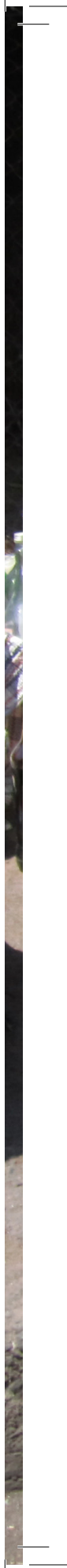
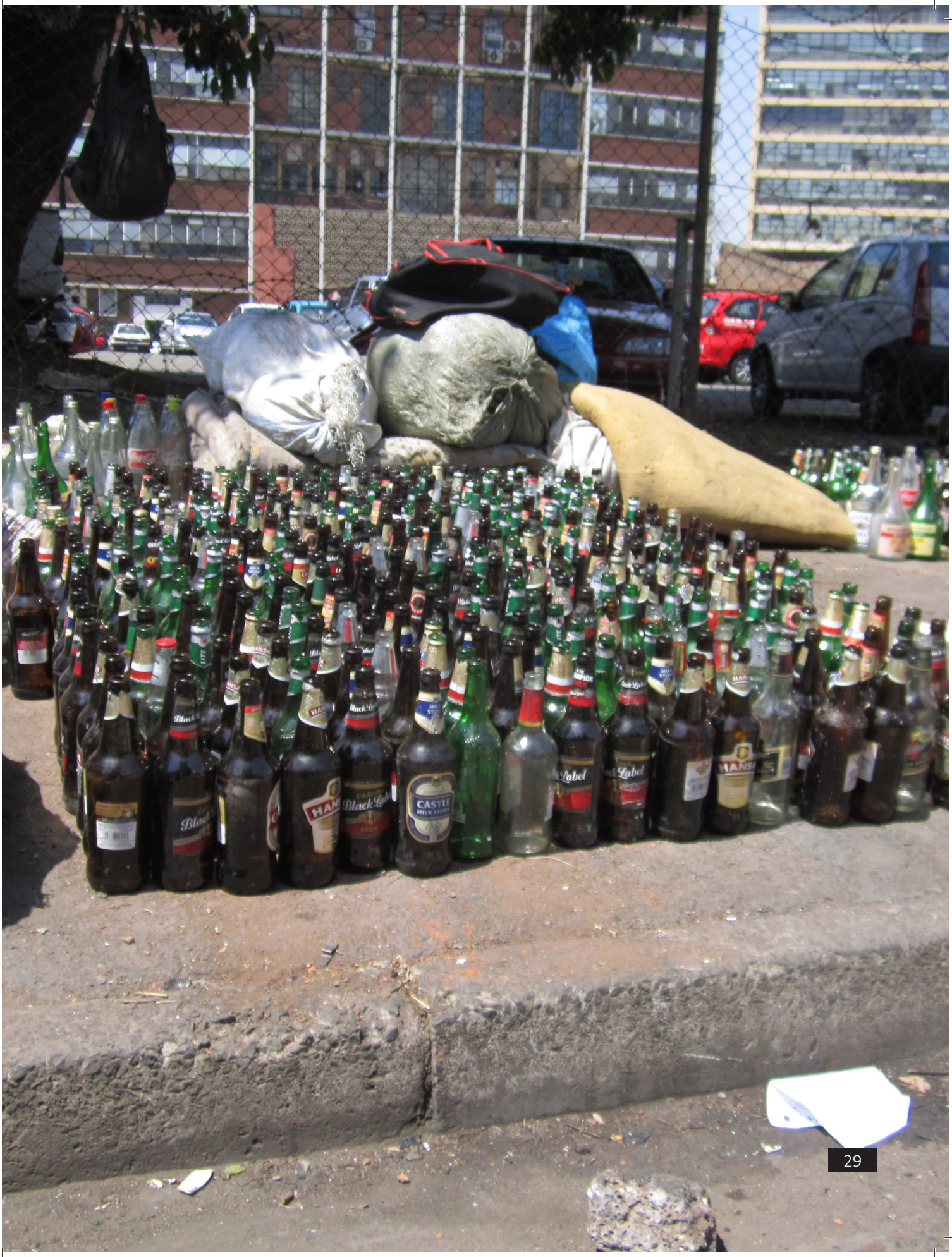


Figure 2.11 - Glass Bottles sorted by waste reclaimers along the street.


CASTLE
MILK STOUT
Black Label

PHYSICAL CONTEXT

A case for selecting Newtown

An opportunity arose to assist the EISD with research on the waste reclaimers productivity and efficiency of waste recovery through the comparison of the newly designed trolley by EISD and the traditional trolley.

The study documented roads utilized and distances covered by a selected sample of registered waste reclaimers that operate from Newtown and Doornfontein. A single GPS device was used during this investigation and it was rotated between a sample of six waste reclaimers (Figure 2.12). One rotation was during a two week period where an individual was tracked and the data was recorded by Trovano Technologies. The trolley routes and distances covered by the Waste Reclaimers was documented on Trovano Technologies tracking system.

The results of this study have been complied in a map format to show the extent of the network of the various routes traveled (Figure 2.14 & 2.15)
The finding revealed that the newly designed trolley (green trolley) was not effective with an average total distance of 4km as opposed to an average total distance of 30km covered using traditional trolleys. The general response from the Waste Reclaimers was that this trolley was too heavy and that it was difficult to negotiate in the traffic and it had limited movability.

Figure 2.12 - GPS Devise

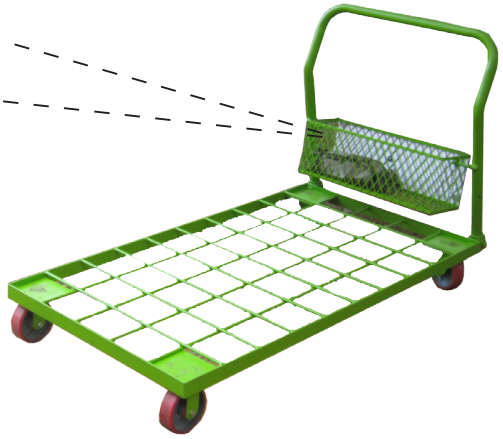


Figure 2.13 - EISD Designed Green Trolley

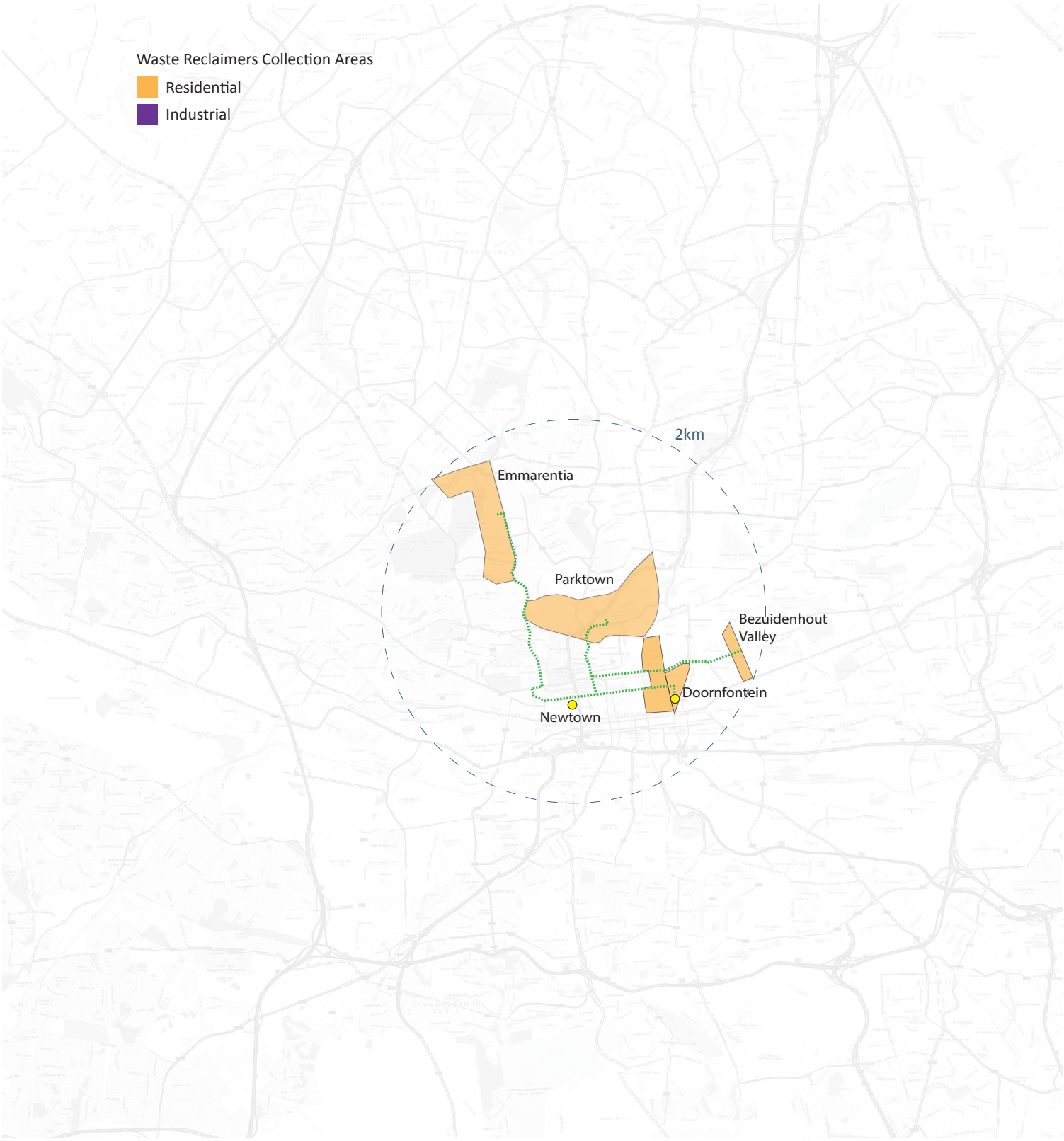


Figure 2.14 - Network of EISD Designed Green Trolley

The traditional trolley (figure 2.16) was recorded with a maximum distance range of 15km with a total traveled average distance of 30km (Figure 2.15) This variation in distance between the two trolley designs reveals that the traditional trolley is much more efficient and effective.

The general response from the Waste Reclaimers is that this design is light and easy to maneuver. This, therefore highlights that the design of a trolley can impact greatly on the Waste Reclaimers ability to collect waste. The area of collection will greatly be affected and productivity will therefore be altered.

It is thus suggested that newly designed trolleys need to take the precedent of the traditional trolley into consideration as this has been developed by the user and perfected over a number of years.

Figure 2.16 - Traditional Trolley

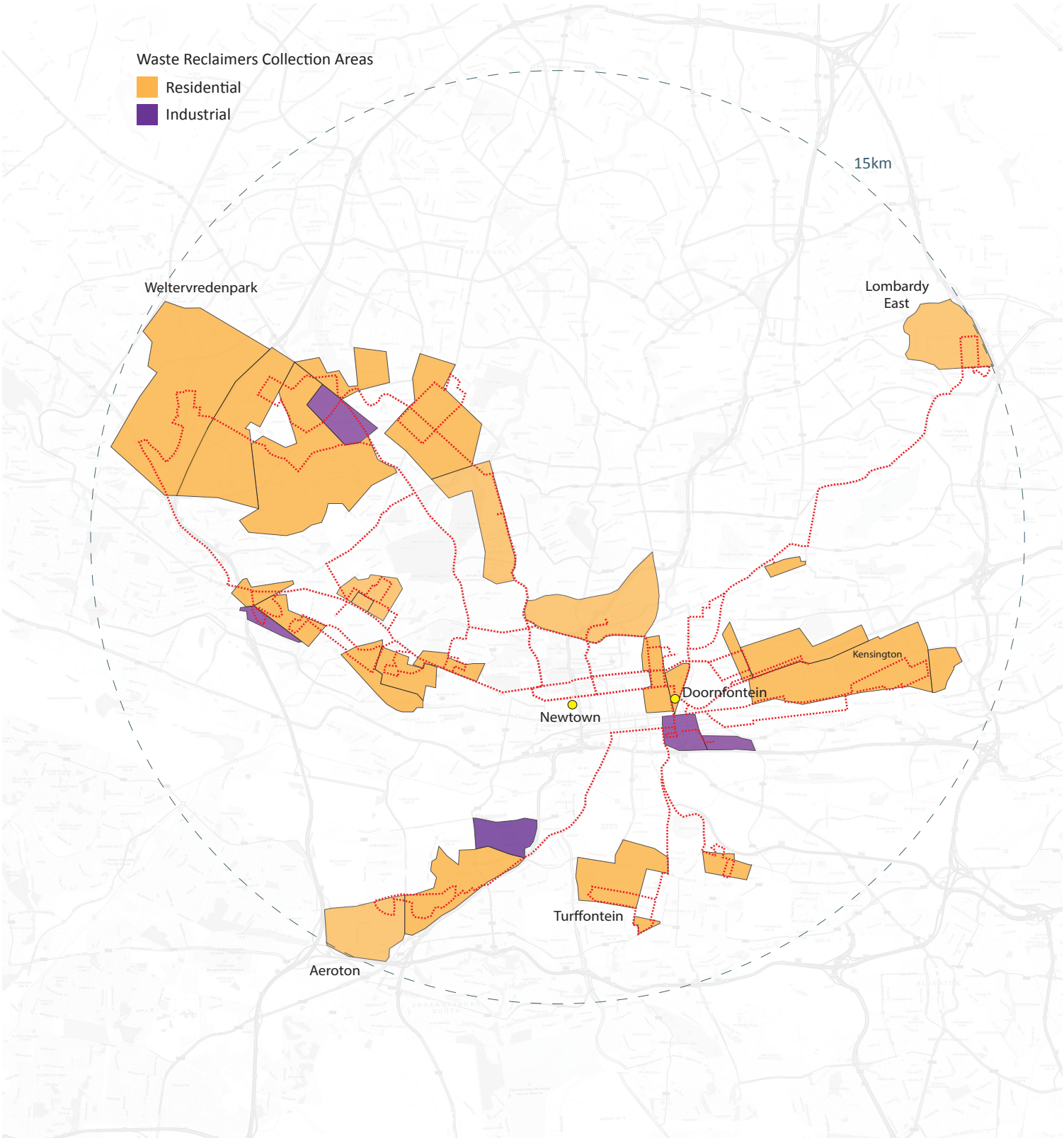


Figure 2.15 - Network of the Traditional Trolley

The overall study conducted further assisted the selection of the proposed site location. The mapping of the various networks revealed that a centrally located position within this network of the Waste Reclaimers is the area of Newtown which is located to the west of the Johannesburg Central Business District.
(Figure 2.17 & 2.18)

Figure 2.17 - Network of the Traditional Trolley

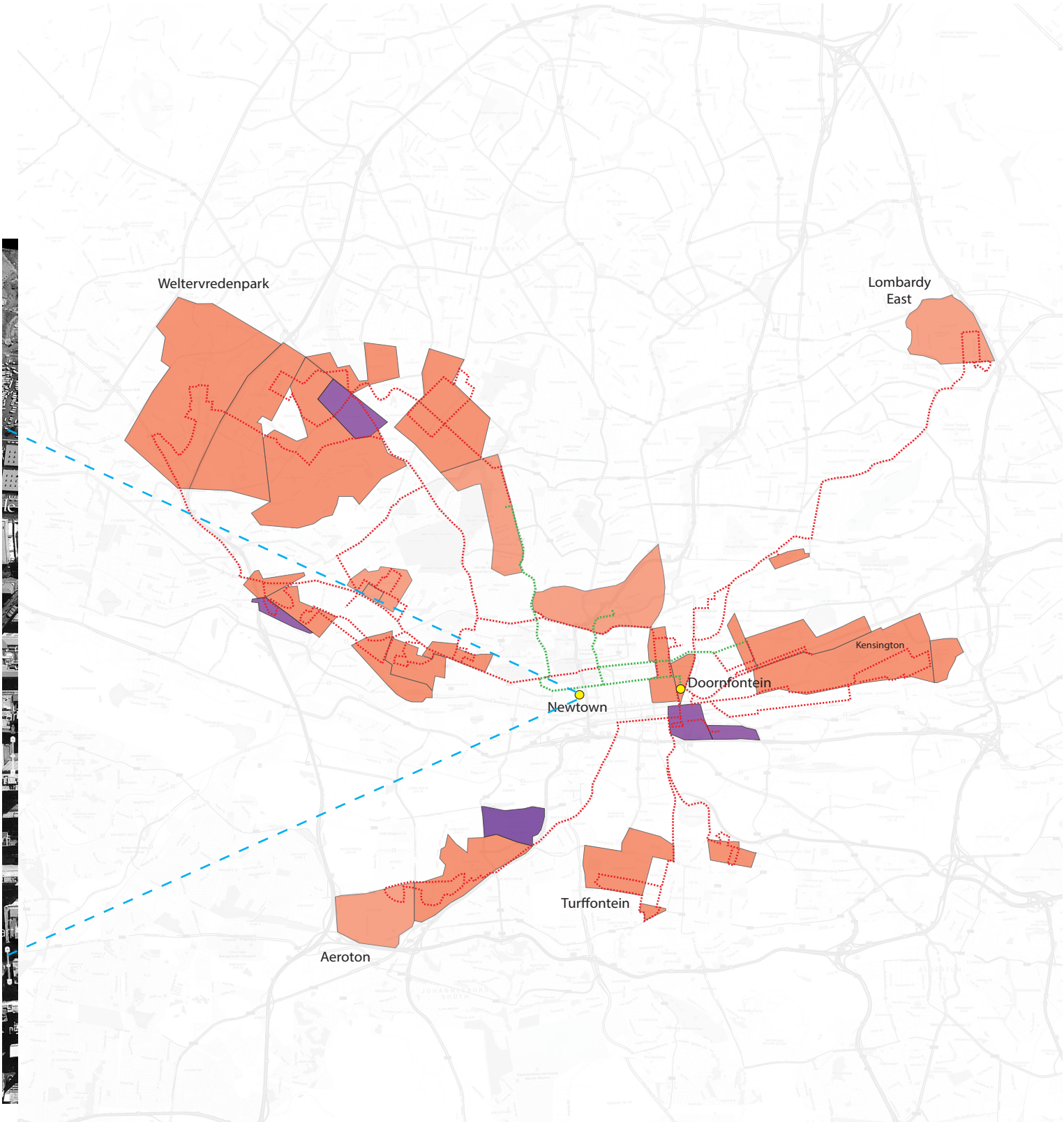


Figure 2.18 - Combined Network of Waste Reclaimers

Figure 2.19 - Figure Ground Map of a Johannesburg City

Figure 2.20 - Map of South Africa

Figure 2.21 Map of Johannesburg City and surrounding areas

Newtown, is an area marked by a history of industrial and political disruption. This area represents change and opportunity, growth and life. A space recycled and generated throughout the history of Johannesburg plagued by moments of flux and pause in terms of its development. The industrial section of Newtown provides an opportunity for the combination of a mixed-use industrial building. It is an area closely linked to the cultural core of Newtown's precinct. This cultural hub enhances Johannesburg's cultural history through the means of museums, arts and crafts and music. The proposed site allows for a connection between the industrial past and celebrates craftsmanship within a lost industry. It is also where the few remaining small industrial typology for small industry are located within the city of Johannesburg. Newtown is also the location of one of the major buy-back centres; namely Remade (®). The area is also central to the other outer lying buy-back centres, recycling companies that the waste reclaimers service (Figure 2.19). The selected site is also owned by the city which is currently being used for a Metro Bus depot. This provides an opportunity for the proposal to be that of a public-private partnership between the city and a Co-Operative of Waste Reclaimers.


R
Site

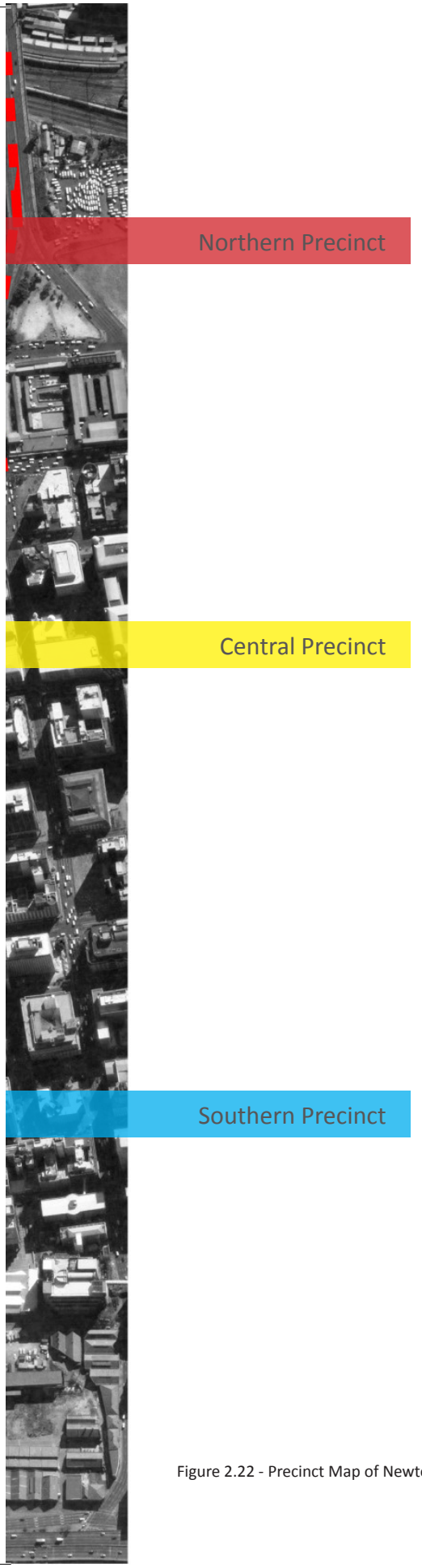


Figure 2.22 - Precinct Map of Newtown

Previous Urban Design Framework

In April 1999 the greater Johannesburg Metropolitan Council adopted “the Outline Spatial Framework for the Johannesburg Inner City” as a means to guide the future development of the inner city of Johannesburg (GAPP Architects,2003).

The Newtown Urban Design Framework identifies three primary precincts: Northern precinct, Central precinct (including the Newtown Cultural Precinct) and Southern precinct. (Figure2.22)

The aim of the development framework is not to manage zoning but rather to adopt an overall policy, the strategy and rights within the area and to facilitate the development in terms of their policy. It also involves the planning and urban design for an area within its context as a process and not as fixed-state master plan. It therefore needs continuous re-evaluation and refinement as circumstances change. The primary aim is to develop policies, procedures, design criteria and strategies to achieve agreed goals as well as to benefit the area and the city as a whole (GAPP Architects,2003).

The Vision of the Precinct Plan

This vision of the precinct plan designed by Gapp Architects and urban designers emphasizes a human-scaled, active, vibrant public environment. The Precinct falls within a hub of art and cultural activities, with supporting retail, commercial, business, office and residential uses. (Figure 2.24)

The principals guiding the vision include the following:

- To create a pleasant pedestrian environment that emphasizes a human scale of development.
- To create a hierarchy of vehicle movement to instill a pedestrian environment.
- An emphasis on continuous public environment network.
- Incorporate landscaping and the promotion of mixed land use.

(GAPP Architects,2003).

The development plan concept of Newtown Cultural Precinct Plan focused on the area bounded by President, Goch, Carr and Wall Streets. It seeks to enhance the existing activities of the Market Theatre, the African Cultural Centre and the Museum Africa complex. (Figure 2.24)

From a spatial perspective the development concept integrates the existing activities and adds further linkages to the nearby areas thereby incorporates an interlinked system. The Mary Fitzgerald Square, Newtown Piazza and Turbine Square are connected by pedestrian routes and lanes. Additional pedestrian routes from the core area have also been introduced to the Johannesburg Central Business District and Church Street, the Oriental Plaza to the proposed Craft Centre and West City, to the Transnet Railway land and Braamfontein and to the Metro Mall development (GAPP Architects,2003).

Newtown West has a different built-form character and land use to the Cultural Core. (Fig2.23) This district has been earmarked as an opportunity for regeneration and upgrading, emphasized by the interconnected links and activities within the Cultural Core (GAPP Architects,2003).

The Proposed site for this project is located in this western section. The precinct plan originally zoned this site for housing. However, the proposal for the glass recycling factory will provide a unique mix of activity that will help enhance the diversity and add value to the existing context. (Figure 2.23)

It is therefore proposed that the city owned land be utilized for The Glass Recycling Factory. It is also proposed that the remaining area of the site be used for high density housing rather than low density town houses. This combination will create a multi-use site that provides employment, education, recreation and housing. The nature of the factory is of a light industrial nature and therefore will not affect the residence within its surroundings. The factory will add value to the area providing employment for the residence and it will also act as a regeneration project for the western section of the precinct.

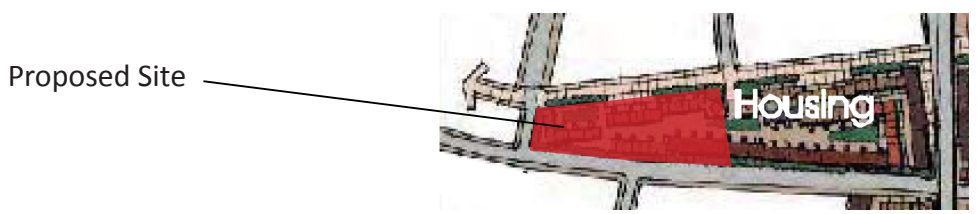


Figure 2.23 - Site Division

Newtown West

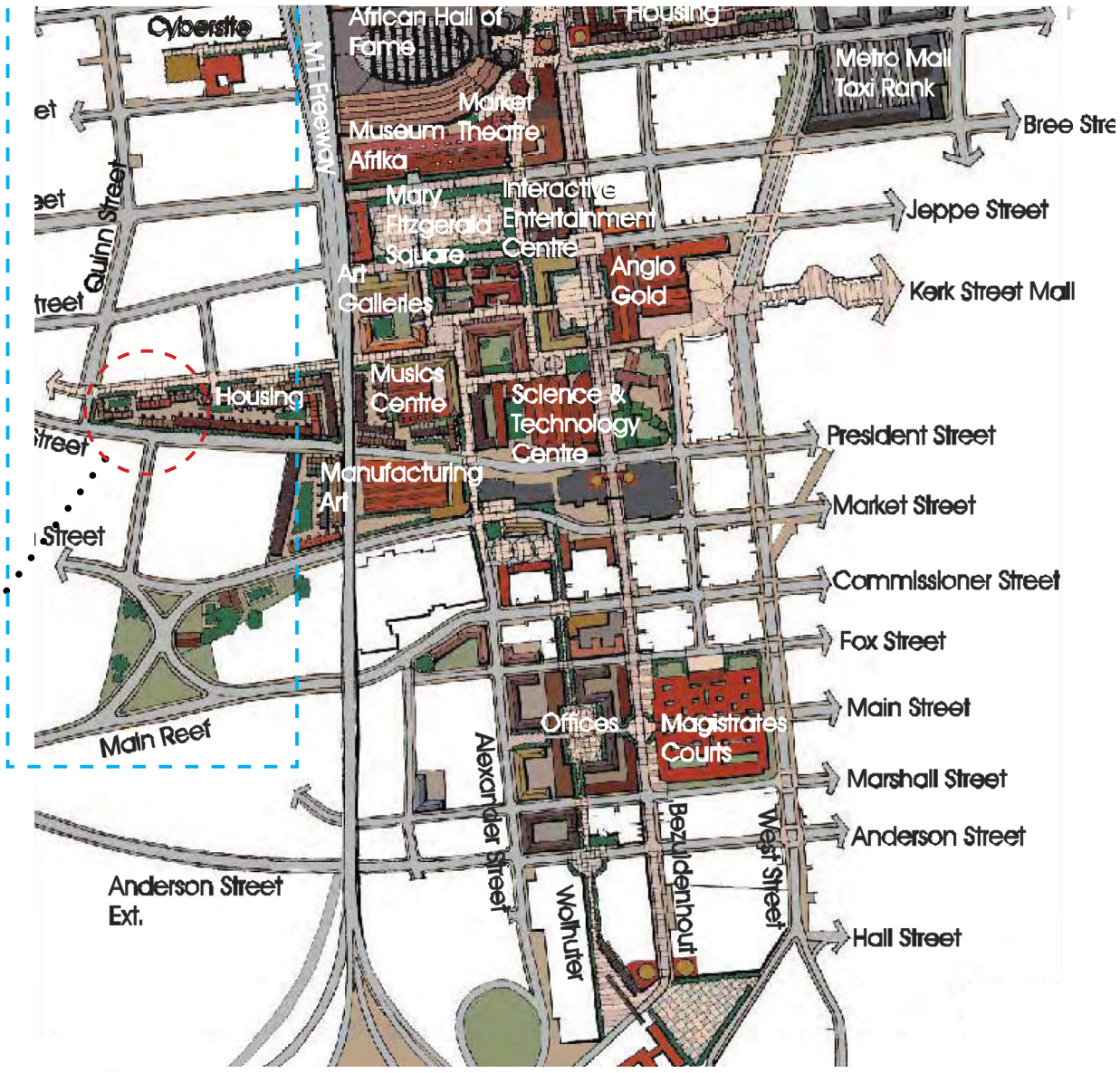


Figure 2.24: The Newtown Urban Design Framework (GAPP, 2003).

Visibility and Connection to site

Due to the location of the site on the corner of Quinn and Barney Simon Street, the site is visually accessible and centrally connected to Newtown. If one imagines a glass lantern on the site, the rays of the light omitted create an idea of visual paths connecting to the site (Figure 2.25). These visual connections create paths along which the different activities of the role players of the proposed glass factory are interrelated and connected. These role players include the

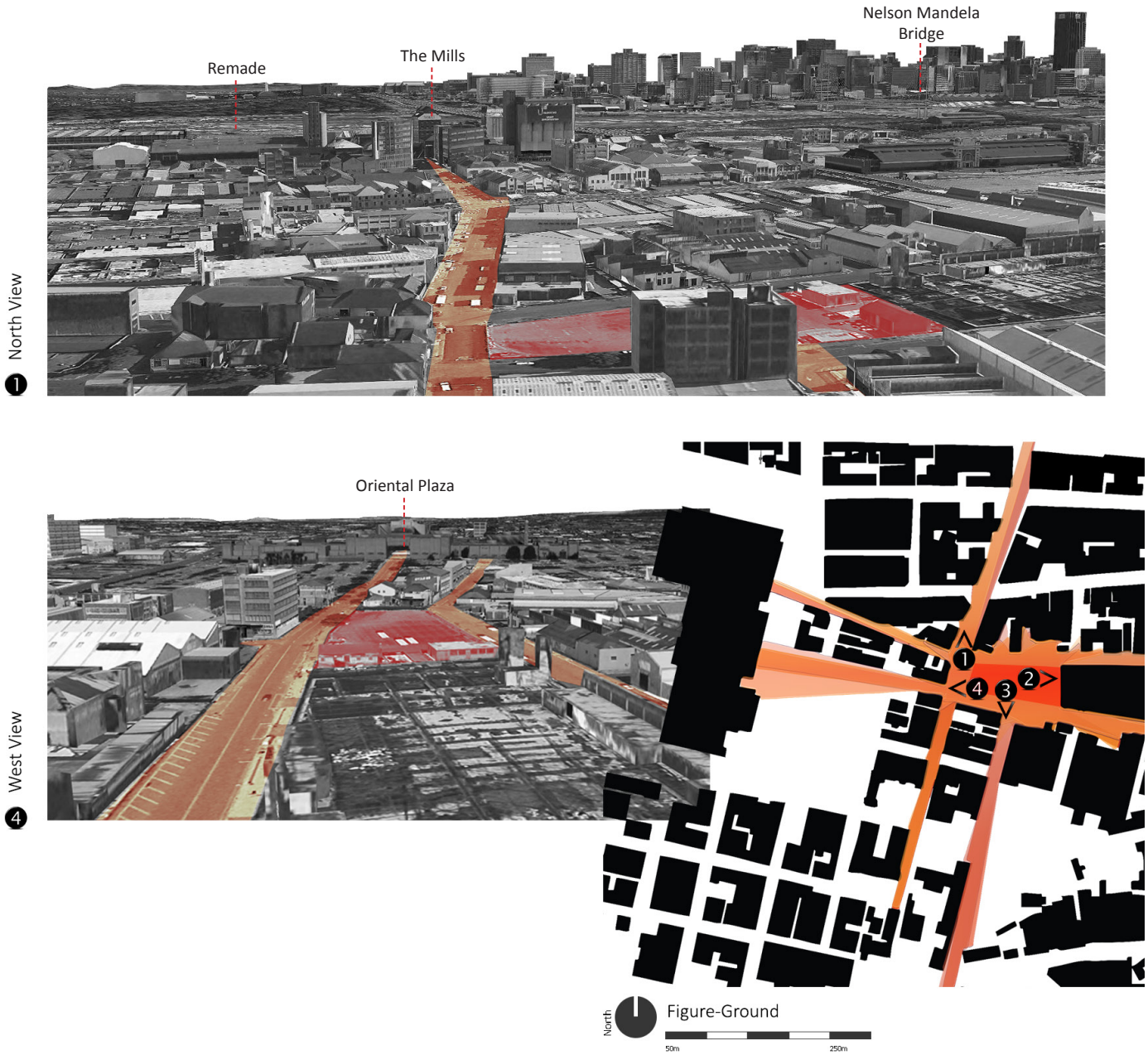
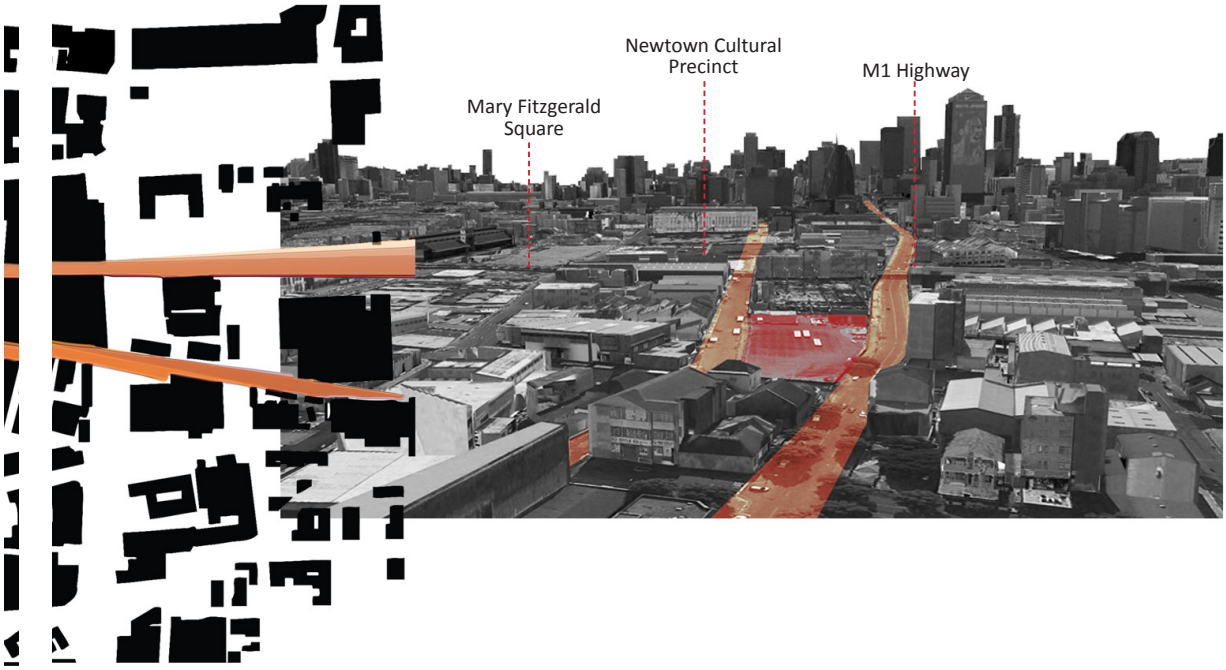


Figure 2.25 - Visual Paths

general public who utilize these paths daily to commute to work or home. The visiting public from Newtown and Oriental Plaza as well as the waste reclaimers who utilize these paths to get to the site. It therefore aligns the paths of the interested visitor and the waste reclaimer creating a dialogue between them. The proposed site can be seen as a node where these paths of visibility intercept. Therefore the proposed site becomes a place of pause between the moments of movement of the Waste Reclaimers and the general public.

3 South View



2 East View

The node of intercepting paths

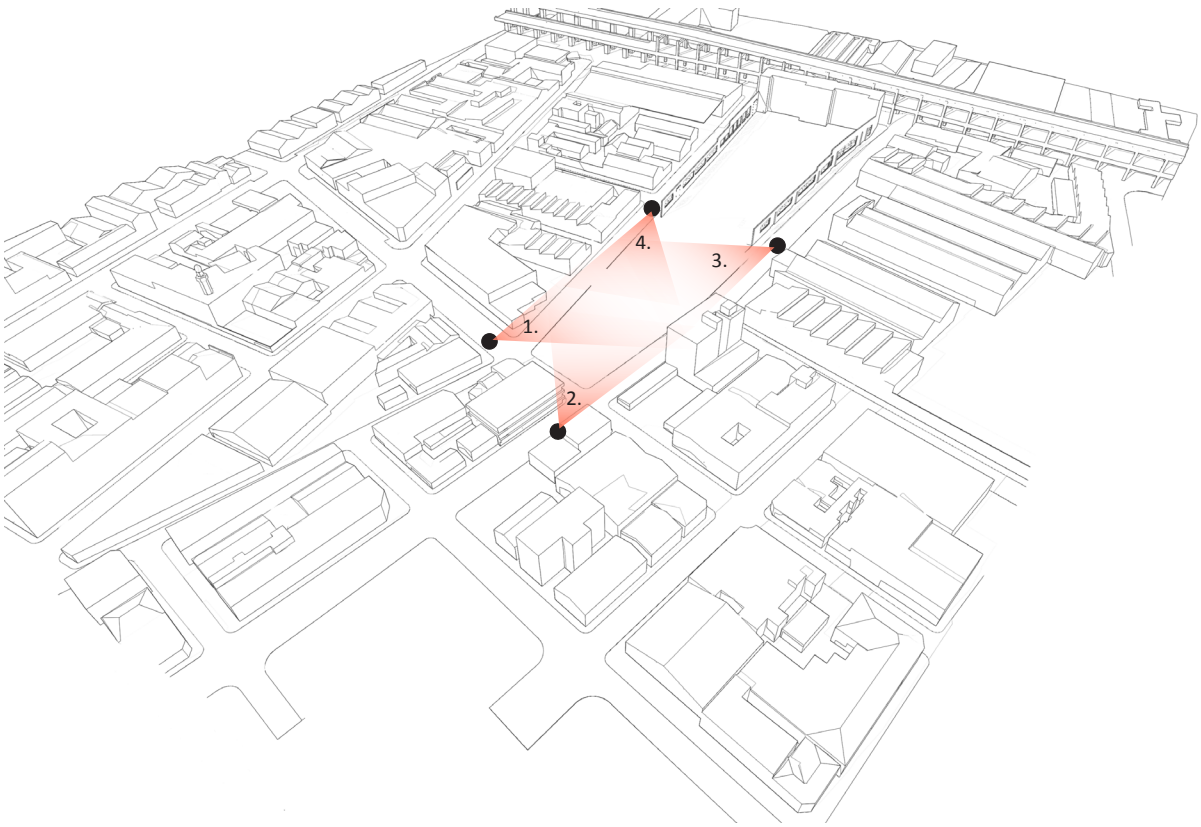


Figure 2.26 - View Fields from street view towards the proposed site

Figure 2.27 - Site View Fields

1.

2.

3.

4.


Site

Movement Network

- Primary Vehicle Movement
- Secondary Vehicle Movement
- Public Transport Nodes
- Existing Trolley Network
- Proposed Trolley Link to Site
- Pedestrian Friendly Network
  (as per urban design framework GAPP)

Figure 2.28 - Movement Network relating to proposed site, Newtown.

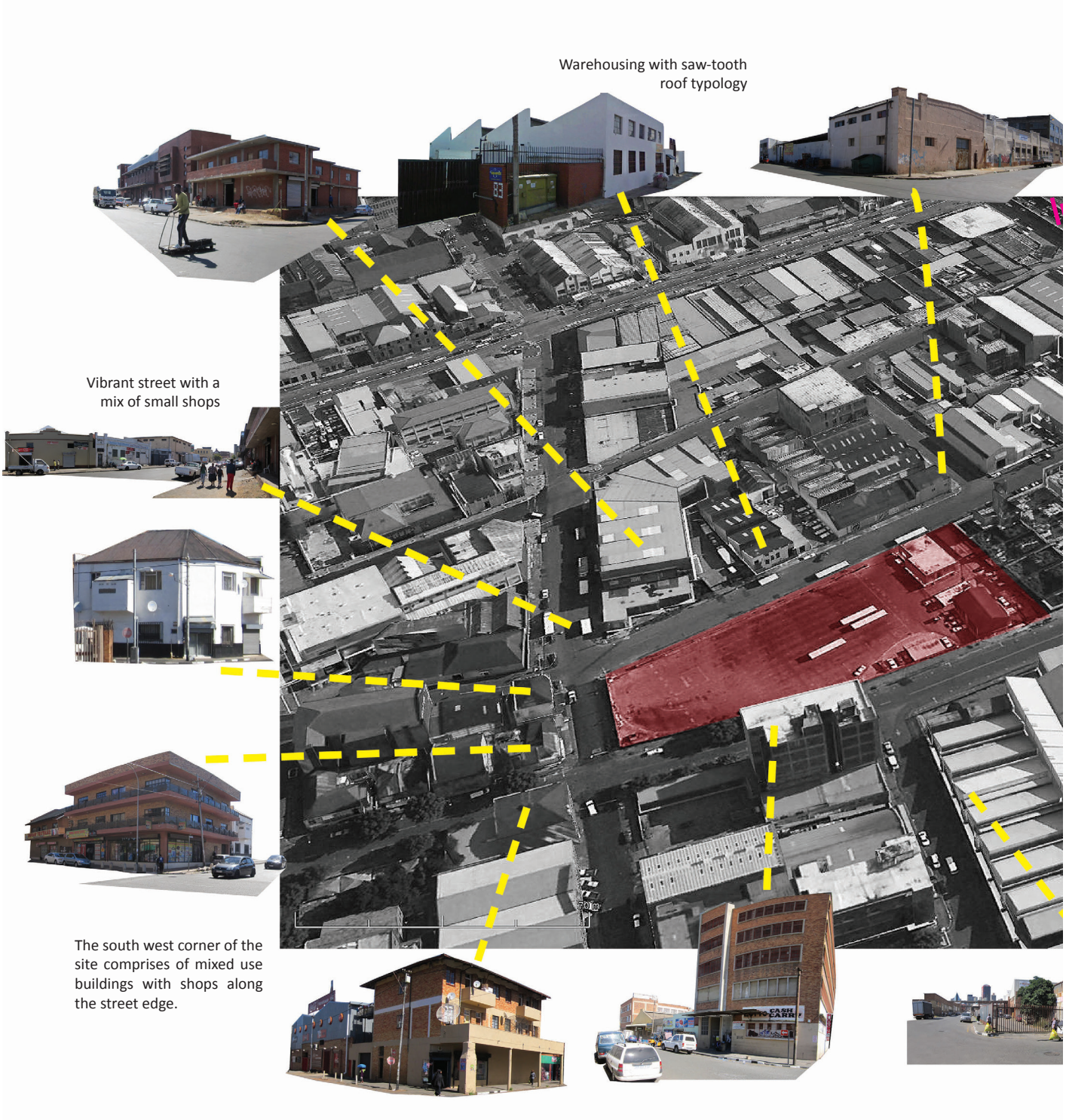
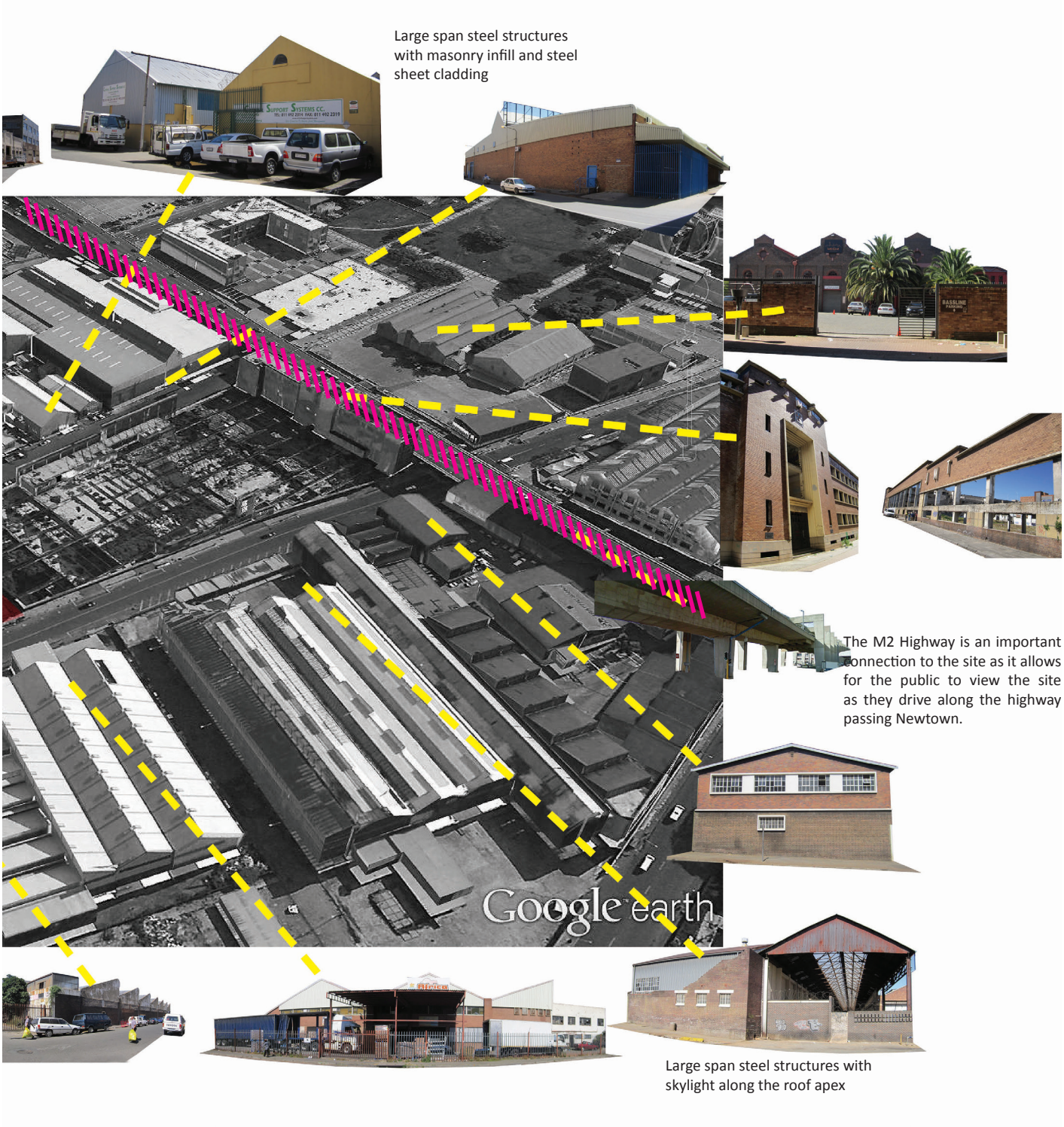


Figure 2.29 - The Character of the surrounding physical context
(Finding a medium in terms of land-use for the proposed building)



Large span steel structures with masonry infill and steel sheet cladding

The M2 Highway is an important connection to the site as it allows for the public to view the site as they drive along the highway passing Newtown.

Large span steel structures with skylight along the roof apex

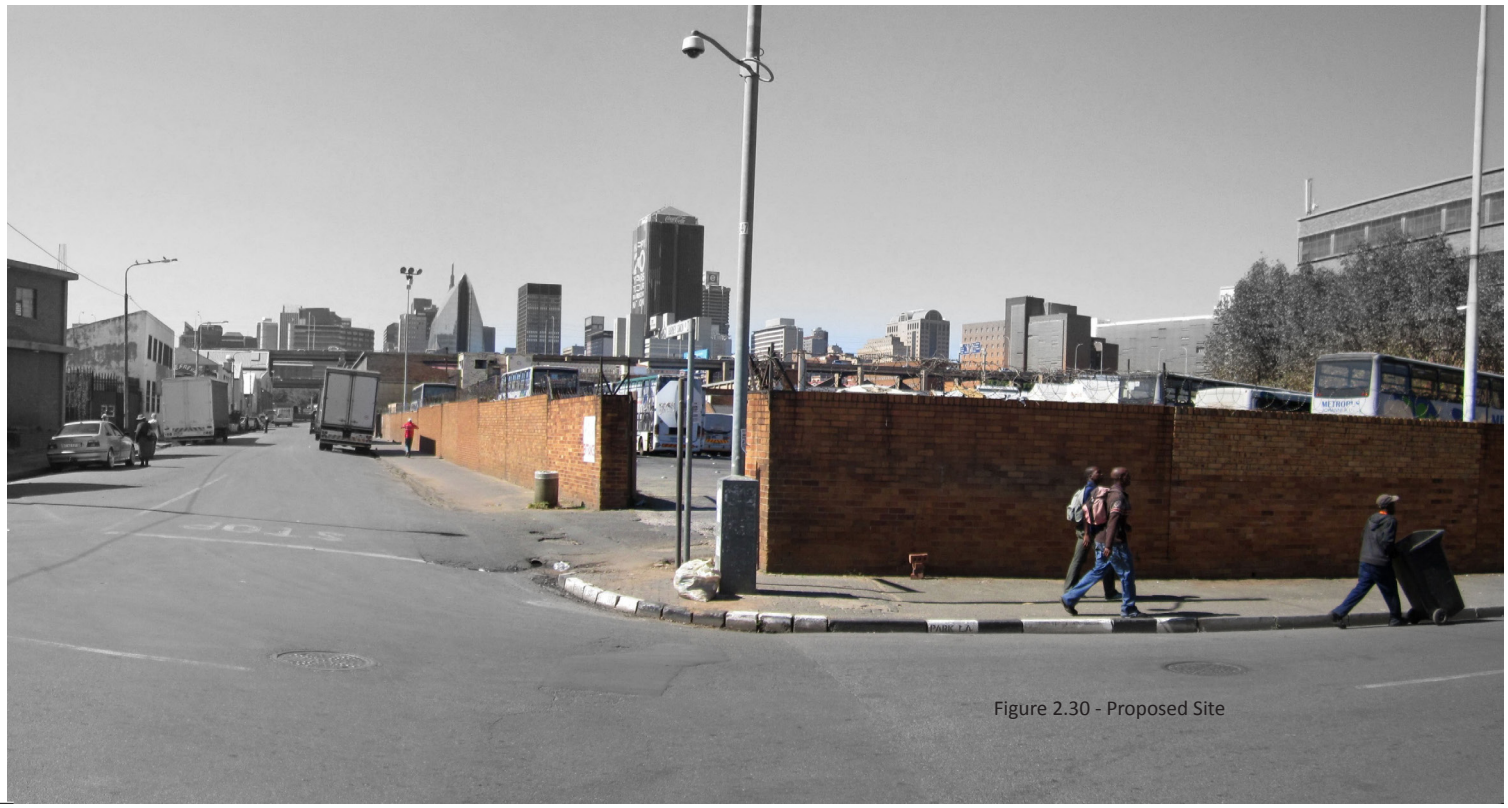


Figure 2.30 - Proposed Site

03 |

THEORETICAL DISCOURSE

"In our daily life, we normally give little attention to what our world is or how moment-to-moment experience unfolds. The Lifeworld is just there, taken-for-granted, with situations, events, and experiences just happening. There is normally no consideration as to why an experience happens as it does, whether it could happen differently, or what larger lived structure the experience might be a part of" (Seamon, 2007:09).

Enhancing the life of Waste Reclaimers through the concept of 'Lifeworld'

This thesis attempts to create a wider spectrum of opportunity for social and economic mobility, achieve greater decision-making powers of the marginalized in their everyday life, access greater market involvement, and achieve greater participation in people's own destiny through unlocking opportunities for linking into more advantageous networks of social capital, and developing people's potential for entrepreneurship, education and skills development.

One useful way of understanding how a person or group can achieve a greater level of participation, involvement, and control in and over their own lives, is by considering the idea of "lifeworld." Lifeword is a way of describing a way of life where the individual's aspiration, perceptions, experiences, beliefs and behaviours forms a holistic unity towards a fulfilling, meaningful, existence. The literature in phenomenology often refers to the idea of "Lifeworld" as a way of "being" in the word. The term Lifeworld means that through achieving a high degree of unity and integration between the physical (material) and spiritual world, the personal, the collective, and place (context) and time, people are able to access and participate in the greater meaning and purpose of life (Seamon, 2012).

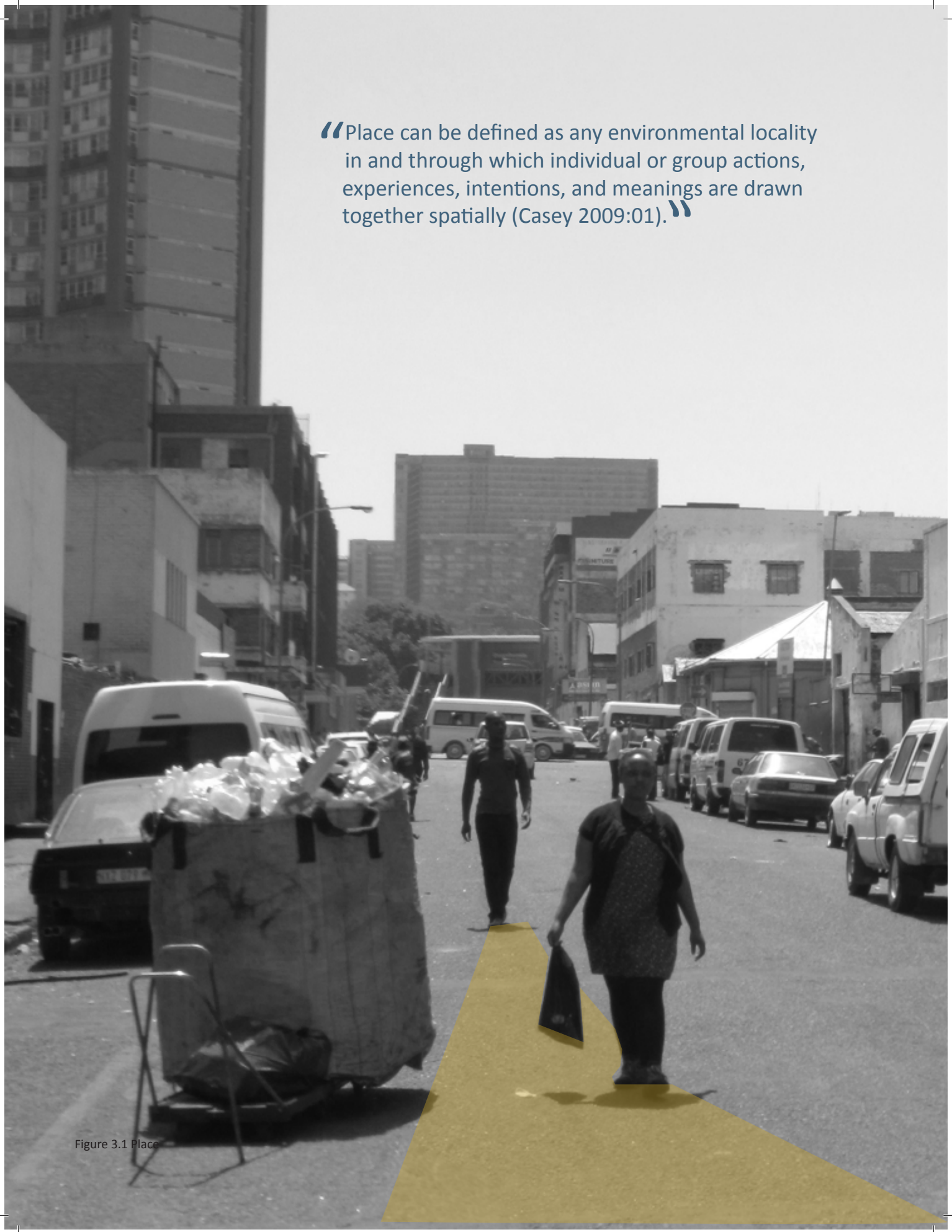
In terms of, this thesis, the idea of lifeworld is useful to create change amongst a marginalized group of the Waste Reclaimers, in achieving greater socio economic involvement and supporting people to achieve their potential through entrepreneurship and skills development. If one were to apply lifeworld to consider how to improve the lives of the Waste Reclaimers currently, the following opportunities can be identified: Creating opportunities for Waste Reclaimers to climb the social and economic ladder; connecting these entrepreneurs of recycling into a greater social network of opportunities consisting of training specialists, financiers, business, education, retail and community collaboration. Therefore, the purpose of this proposed architecture is to achieve a unified lifeworld in which people can change and transform their own lives through the life possibilities that the architecture offers them. This new space will provide them with a greater sense of orientation

and identity. Within a network of movement this moment of pause in the form of a glass recycling factory will create a sense of place and belonging. It will also become a place of making and exchange, for the Waste Reclaimers. This space will also provide social learning through the opportunity to view, experience and become evolved in the entire process of glass recycling. This will therefore increase skills development and provide an opportunity to improve social and economic status.

Lifeworld and place

Place can be defined as any environmental locality in and through which individual or group actions, experiences, intentions, and meanings are drawn together spatially (Casey 2009) as cited by Seamon (2012:01). Therefore, Seamon explains that people and their worlds are integrally intertwined. These individual worlds are described to be the everyday structure through which this lived interchange unfolds is referred to Lifeworld (Seamon, 2007). It is about experiencing but also participating in the larger context of life. He further explains that a place can range in scale from a furnishing to a room, building, neighbourhood, city or region. It is place, that hold Lifeworlds together spatially and environmentally, marking out centres of the human meaning, intention, and behaviour that in turn helps create place (Relph,1976) as cited by Seamon (2012:01).

The aim therefore is to enhance awareness of experience through creating conditions and opportunities that challenge perceptions, ways of doing, and how we participate in the world and access resources to maintain of physical and mental well-being.



> "Place can be defined as any environmental locality in and through which individual or group actions, experiences, intentions, and meanings are drawn together spatially (Casey 2009:01)."

Figure 3.1 Place

Lifeworld as a way of overcoming modernity: specialization and the assembly line.

The 21st Century marks a culture of mass consumption; the purchase, discard and repurchase of large quantities of machine-made goods (Bob Casey, 2010). This has been the direct result of mass production and the adoption of the assemble line to create cheap and affordable products.

The principal of the assembly line proposed that rather than one worker assembling the entire product himself a sequence of workers would be used to assemble the different components of the product (Bob Casey, 2010). Henry Ford considered the assembly line as truly revolutionary as it resulted in increased productivity and lowered production costs (Bob Casey, 2010). However, the assembly line creates a number of social repercussions. For example, mechanization within a production process of the textile industry has lowered the skill level required to spin yarn. This has therefore lowered the value of labour and it leads to the devaluation in education. Casey (2010) explains that it is possible to increase quality and productivity by involving the employees in all aspects of the process. He further states that it is vital that workers are educated, engaged, and capable to perform a variety of different jobs in the manufacturing process. Therefore, people should be part of the whole process, not just one task. They will develop a sense of pride by developing unique expertise on one task, but can move up to a more challenging task once they have achieve excellence. Throughout their lives, they can play a role in the whole process from start to finish.

"The man who works recognizes his own product in the World that has actually been transformed by his work. He recognizes himself in it, he sees in it his own human reality, in it he discovers and reveals to others the objective reality of his humanity, of the originally abstract and purely subjective idea he has of himself" Alexandre Kojève as cited by (Crawford, 2006:2).

Factory spaces are associated with very functional spaces housed under a simple large span steel frame structure that separates the different specialized zones of production. Architecture however provides an opportunity to emphasize and enhance the relationship between the different aspects and stages of an industrial process. This can be achieved by providing opportunities for social interaction through the adjacencies of activities within the process. This creates an opportunity for social learning

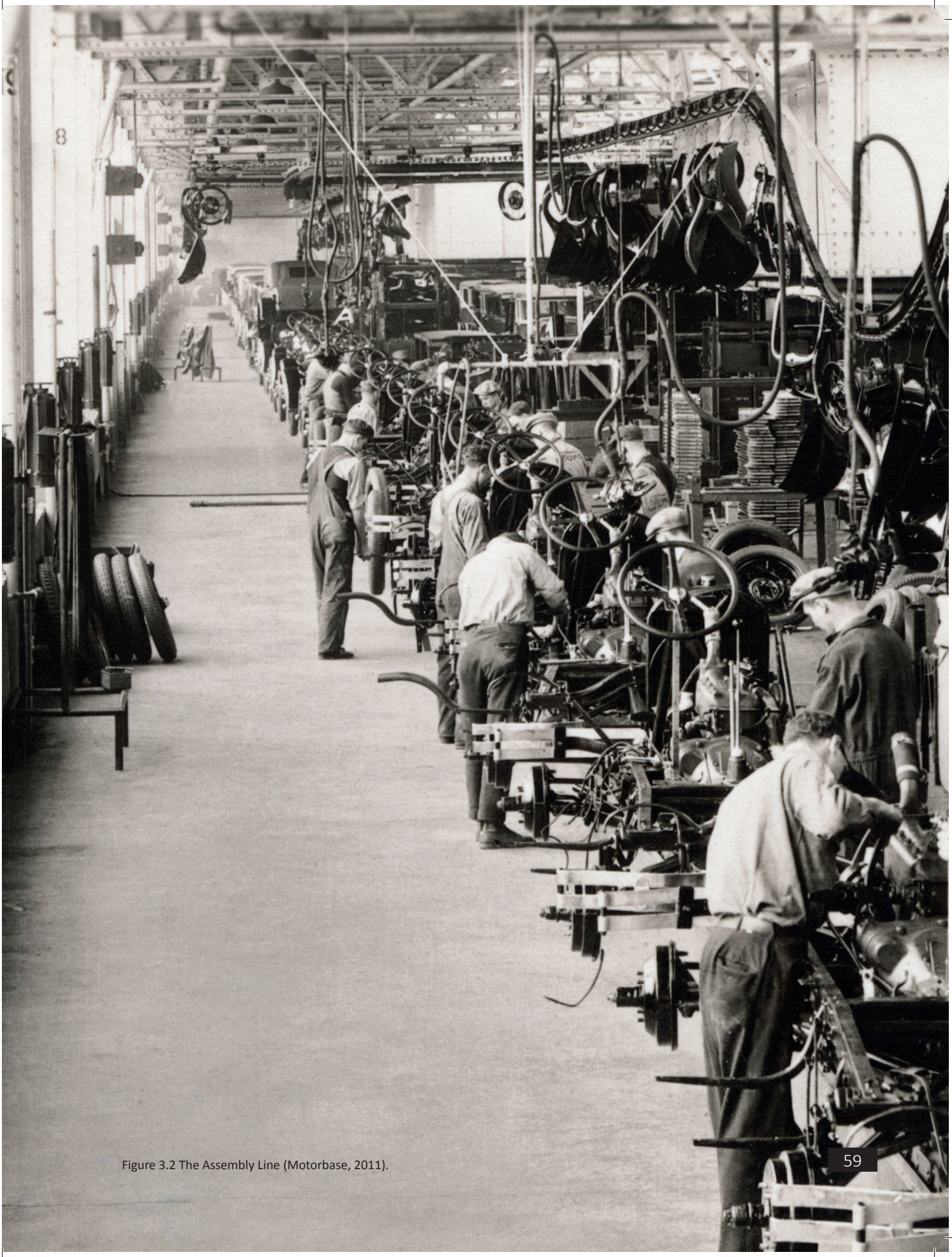


Figure 3.2 The Assembly Line (Motorbase, 2011).

through interaction and visually experiencing the various parts of the process. This thesis therefore proposes that through the interaction and visual experience achieved from exposing and revealing the functional process associated with glass recycling and glass blowing at a small/medium scale production it will create an opportunity for educating people about recycling, learning about glass, and creating opportunities for selling glass products. It therefore exposes how people, things and the world are all interconnected.

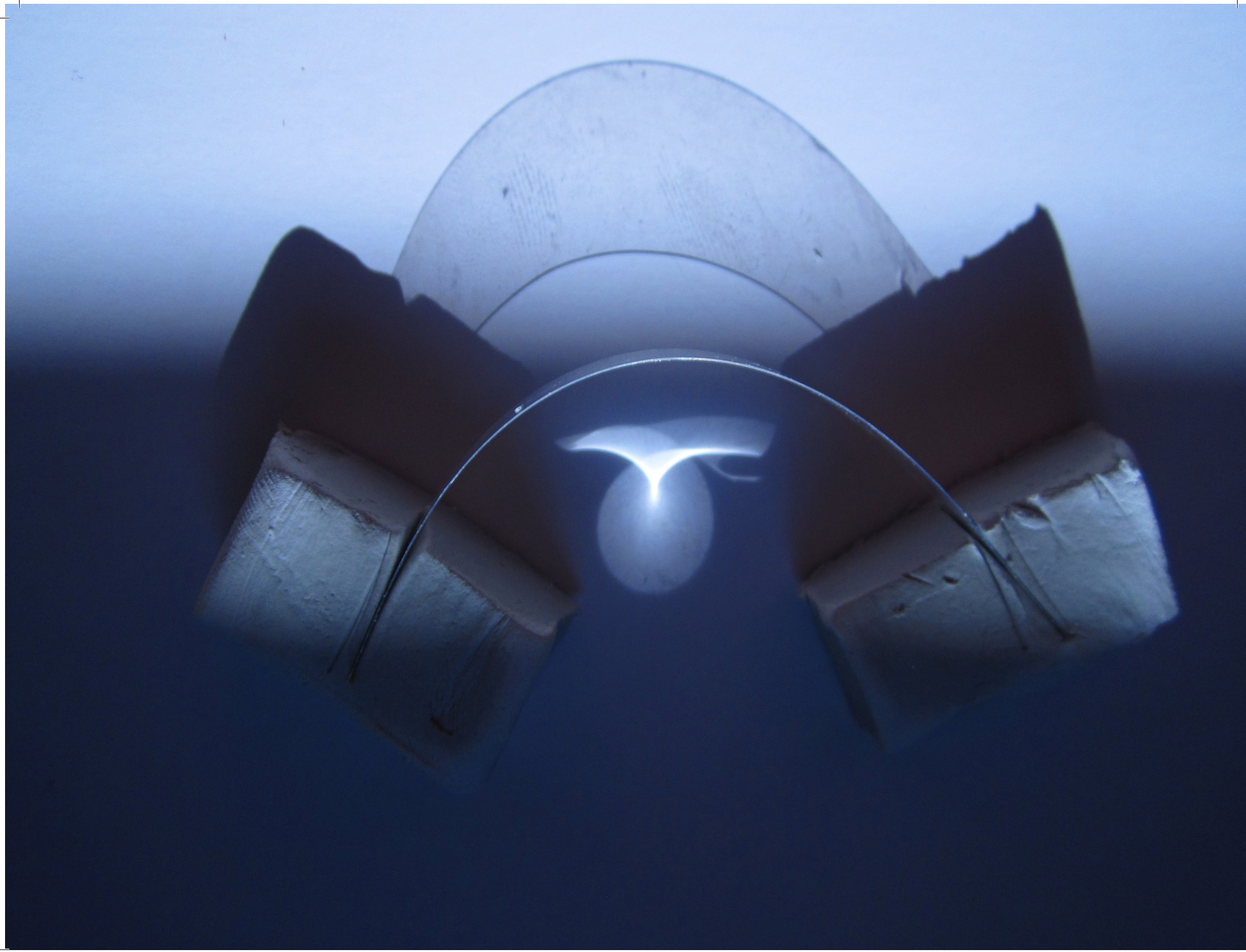
Creating a centre: a building as a node of meaning and opportunity.

The concept of "dwelling" derives from the Old Norse dvelja, meaning to linger or remain. It encompasses both a sense of belonging and a sense of peace and protection. Dwelling also refers to a sense of "gathering" (Norberg-Schulz, 1980). The research design also aims to achieve a place of gathering, not merely for congregating but to incorporate the social, protective, peaceful and identity aspect of the occupation of waste reclaiming. It will also create an environment that will cultivate development and improvement of integrated systems of people, knowledge, information, materials and equipment.

According to Suzanne Langer (Nesbitt, K. pg 426) architecture comes from being when "a total environment is made visible". Man is an important part of the environment. To belong to a place, therefore means to have an existential grounding (Norberg-Schulz, 1976). The proposed research design focuses on transforming the perceived invisibility of the informal waste collectors and their effort in assisting the city's waste management system to allow for the Waste Reclaiming community to be visible, meaningful and where they can belong. In the same way this research incorporates the greater waste management system and not only examining the Waste Reclaimers as the central point in isolation. Rather it aims to understand the Waste Reclaimers within the greater framework of the formal and informal recycling community. It challenges the Lifeworld of the Waste Reclaimers and creates opportunities for them to experience different realities by exposing them to the larger context that they are connected to.

The Genius Loci, a concept derived from the Romans, explains that there is a spirit in all people and places which determine their character. The use of the word "dwelling" relates itself to the man-place relationship. Man dwelling is related to both him being located in space and exposed to an environmental character (Norberg-Schulz, 1976).

Figure 3.3 - Artistic impression of 'Genius Loci'



Norberg-Schulz understands that to dwell, man requires an understanding of who is and how he is, in order to experience existence as meaningful. The two psychological functions involved in this process are “orientation” and “identification”. Orientation involves man knowing where he is. Identification involves how man is in a certain place or environment. According to Lynch (1960) a good environment gives man a sense of emotional security. Man creates mental images within his environment including shape, colour and arrangement. These familiar mental images create a sense of emotional security.

It is however possible to orientate oneself without having identification or a sense of belonging. It is also possible to feel like one belongs without being orientated to a particular place. Real belonging requires that both orientation and identification are fully developed.

The research design aims to produce a central space where the Waste Reclaimers can incorporate a sense of orientation and identification with a specific emphasis on emotional security. Norberg-Schulz (1985) explores three types of dwelling, including collective, public and private. He explains that together, settlement, urban space, institution, and house make up a total environment.

Currently many of the Waste Reclaimers have a sense of orientation but lack a sense of identification or belonging; they only dwell in the public and they create a shared space of the collective (the Waste Reclaimer network). In modern society, there has been a focus on the “practical” function of orientation and identification is often left to chance. The Waste Reclaimer community do have the practical function of orientation. They have the streets, the waste available and the collection sites. Perhaps their only true sense of identification is their trolleys that belong to them. True dwelling has become in their reality, their movement through the streets. They dwell only in the shared space of the public. They do not belong anywhere, but everywhere.

Figure 3.4 - Shared Space for recyclable waste storage.

Identification means to belong within a particular environment. When one belongs, our environment is experienced as meaningful. People within modern, urban settings rely less on their natural environment to create meaning and more on fragmented things such as streets and houses. Human identity is both a function of places and things. Dwelling means to belong to a concrete place (Norberg-Schulz, 1976). The current research design aims to create a space not merely for practicality but a place that becomes meaningful for the Waste Reclaimers.

Open-systems as a way of broadening the life world of informal waste collectors.

Salat (2014) suggests a good network has the character of an open system. This is a system that is constantly exchanging energy and matter with its external environment in order to maintain its structures. "Like all living organisms, cities are evolutionary open systems. They are shaped and constantly transformed by social and political struggles as well as market forces" (Salat et al.,2014:79).

The streets of Johannesburg that Waste Reclaimers use to access recycling material can be seen as a network or a system. However, they do not use all the streets, but select certain streets to most efficiently connect their collectables with recycling facilities. Currently, these specific networks can be seen as their space of experience, or their Lifeworld. In other words, to achieve the most efficiency and create a good network for the Waste Reclaimers, the network should resemble the characteristics of an open system as suggested by Salat.

In order for their current movement system to become a more “open network”, the following needs to be done. They need to be integrated and officially recognized within the existing waste management system. The waste reclaimers can be compared to a self-organizing system that is perceived to be disorganized however, it has diversified and contributed to the formal waste management system. Salat (2011) explains that an efficient system will be created through the evolution of several processes of construction and destruction. Therefore, to become efficient, systems need to complexify at every scale, from the biggest elements to the smallest ones (Salat, 2011). The emergence of this relationship between the formal and informal waste management of Johannesburg should therefore be embraced to allow an efficient system to evolve.

Considering the waste management as a system, there may be lessons from theory to improve the current system. Salat (2011) cautions that defining an organization of a city in terms of a system cannot be compared to that of an artificial machine. The city remains open and receptive to its environment and the productive instability created by the constant activity of people and transformations of societies. Therefore, cities exhibit a different nature and logic to that of machines. Cities like life itself have an ability to create complexity according to a much more versatile logic than that of an artificial machine (Salat, 2011).

For example the self-organization ability of a city which displays the unified relationship between disorganization and complex organization (Salat,2011). The disorganization of cities tends to ruin their organization, however at the same time they are able to grow and become more complex in an organic way out of this disorganization (Salat, 2011). It is through the disorganization and spontaneity of the city that allows for death and re-birth and regeneration (Salat, 2011).

The emergence of recycling Buy-Back centres within the waste management system can be referred to as the beginning of the regeneration of the waste management system. They have provided an unofficial link for the Waste Reclaimers to the formal sector. These centres buy the recyclable waste collected by the Waste Reclaimers and then sell it to the large scale recycling mills and factories.

This thesis however proposes that The Glass Recycling Factory will strengthen the existing network through diversification. This will help the network evolve by the addition of a sub system of low/medium scale recycling and manufacturing. This will assist in creating new economic activity with regard to craftsmanship and specialized production adding value to the current market.

Organic systems: a way of making cities more efficient and sustainable through enhancing the role of Waste Reclaimer.

According to Salat (2011) modern cities have become simplistic, mechanical, and functional which causes an enormous waste of energy and resources. Salat(2011) states that the qualities of historic cities should be kept in mind. Historic cities have over time become complex, connected and structured according to scale hierarchies. Historic cities can be compared to the semi-lattice structure of a leaf (Salat, 2011). This historic structure joins and intertwines the fabric of space. It contains small, narrow streets that join to bigger, wider streets which are then connected to wide boulevards. This hierarchy results from the reaction of the fluctuations of flows that run through them.

The recycling sector in Johannesburg can learn from this hierarchy in order to survive and flourish. It is important to consider all the elements within the waste management system, which include the formal and informal sectors of this industry.

Currently the formal waste management system of Johannesburg can be compared to that of a modern city which attempts to achieve efficiency though simplistic, mechanical, and functional mechanisms. However, the informal waste collection system has developed spontaneously and organically from the opportunity to sell recyclable waste to recycling companies in order to make a living. This opportunity was created by the development of a recycling industry that diverts recyclable waste to recycling mills instead of dumping at landfill sites. The informal waste collection system comprises of non-motorized and labour intensive solutions which contributes considerably to the recycling industry. This system therefore offers an additional subsystem to the current waste management system. It should not be seen as a component in an artificial machine that causes the system to break down.

Systems forming wholes: integrating.

The recycling industry within the city of Johannesburg is currently an autonomous entity, disconnected from its local socio-economic environment. The current study proposes an opportunity for a vibrant system that enhances meaningful occupations and economic prosperity for the Waste Collectors by integrating them into the entire system. Achieving a good system is to consider the system as a cohesive whole (McDonough, 2008). To consider the entire system, the various processes that will be involved need to be considered, these include cultural, commercial and ecological components (McDonough, 2008). The more diversity there is the more productive functions are performed. If nature is our model, what does it mean for industry to be involved in maintaining and enriching a vibrant system (McDonough, 2008). It means that in the course of our individual activities, we work toward a rich connection with place, and not just with ecosystems: biodiversity is only one aspect of diversity. Industries that respect diversity engage with local material and energy flows, and with local social, cultural, and economic forces, instead of viewing themselves as autonomous entities, disconnected to culture or landscape around them (McDonough, 2008). The recycling industry in Johannesburg and the greater context of South Africa, therefore needs to nurture its current relationships between its different role players. The informal sector through its self-organized structure has provided an opportunity for the industry to diversify and evolve into a unique and efficient system.

04 |

PROGRAMME

A glass recycling factory is proposed to transform the glass waste collected by a co-operative of Waste Reclaimers into new glass products utilizing the art of glass blowing. The design comprises of three main functional programs of: glass collection, processing plant and glassblowing studios. There is also an underlying poetic experiential programme that is developed through the relationship between glass and light.

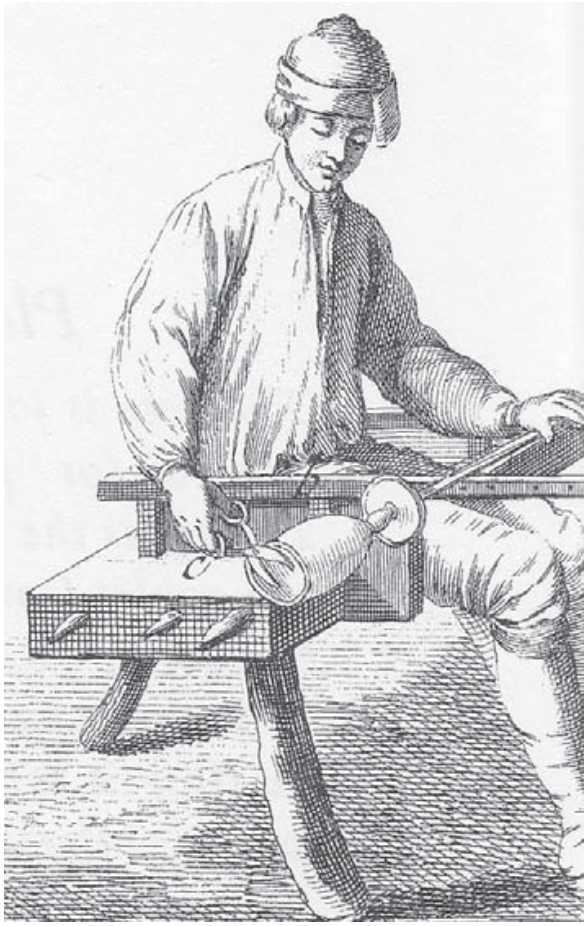


Figure 4.1 Glass Blowing technique (Gillispie, 1959)

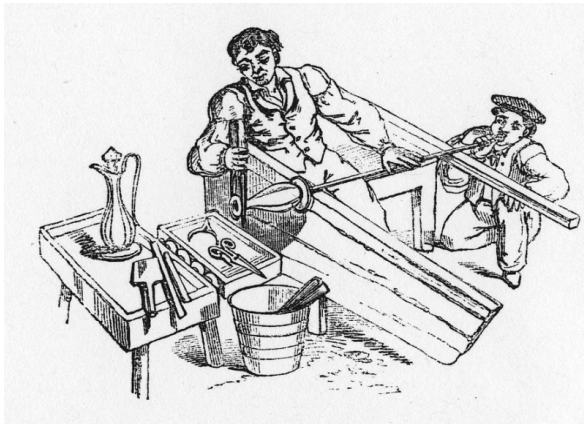


Figure 4.2 - Glass Making (Flude,2010)

History of Glass Production.

The first known glassmakers can be attributed to the Phoenicians, an ancient Semitic civilization found in modern Lebanon and Syria. Some mariners who had a cargo of soda salt landed on the banks of a river in Palestine, started a fire to cook and because they could not find any stones to rest their pots, they decided to lay their pots under some lumps of soda from their cargo. The heat of their fire melted the soda and fused it with the sand found on the bank of the river, producing a transparent glass (Marson, n.d.).

Historically glass was made using crushed flint stones, however today white sand is used due to inexpensive and convenient nature (Marson, n.d.). Glass is made by fusing sand (silica), potash, and soda (alkali) with lime in a furnace, at a temperature of 1500^0C (KQED, 2009). The color of the glass can be altered by adding different metal oxides to the molten glass "batch." For example the addition of cobalt creates a dark blue color, tin creates opaque white, and antimony or manganese results in clear glass. Within a temperature range determined by its composition, glass has the right consistency for shaping by molding, drawing, cutting, pinching, blowing or casting (KQED, 2009).

Glass blowing is the oldest technique of glass manufacture. According to KQED (2002), an important discovery attributed to Babylonian craftsmen in terms of modern glass-making was the use of a pipe for glassblowing around 250 B.C. This same process is used today by modern glass blowers. Glass products are produced by blowing out the hot glass place at the end of a pipe known as the blow-iron into a spherical or pear-shaped bulb. The size and thickness is altered by gathering more or less molten glass. The glass bulb is then finished and shaped using different tools to create a desired form, such as shearing, forming the neck spout, crimping, and sticking on the handles to the various shapes

made (Figure 4.2). The object is then placed in an annealing oven, where it is re-heated and subjected to a gradually lowered temperatures to anneal it (Marson, n.d).

There are different forming methods which can be adopted depending on the type of the goods manufactured. Glassware is hand-made and entirely executed by the handicraft of the workman without the aid of moulds to form. This requires a considerable amount of skill and precision.

A second forming method that can be used is that of a mould. A bulb of molten glass is blown into a mould which shapes it to a desired form. It is then finished by hand with various tools. This is used when a number of articles of one shape have to be produced. For example glass tumblers, jars and containers (Marson, n.d).

The Romans began to use glass in architecture in 100 A.D. They discovered that by adding manganese oxide to the basic mixture it created clear glass. Rough cast glass windows began to appear in the most important buildings in Rome, Herculaneum and Pompeii around this time. (KQED, 2009).

The technique of plate glass was later developed whereby molten glass is fed between two or more parallel rollers (Figure 4.3, 4.4 4.5). The distance between the two rollers is adjusted to create the thickness of glass required. The rollers squeeze the glass out to a uniform thickness. (Marson, n.d). A roughly decorated surface can be applied to this sheet of glass by creating a rough pattern on the metal roller. The plate of glass is then trimmed and when set and stiff it is lifted at one end slightly and pushed forward into a conveniently situated annealing oven, where it is re-heated and subjected to a gradually reduced temperature to anneal it. If a smooth plate of glass is required, the annealed plate of glass may ground and polished level and smooth on both sides. Marson (n.d) explains that this is done by fixing one face of the glass plate in a plaster of Paris bedding and setting it within a mechanical grinding machine.

Figure 4.3 Pouring moulten glass on metal table (Lamberts, 2009)

Figure 4.4 Feeding moulten glass through two rollers (Lamberts, 2009)

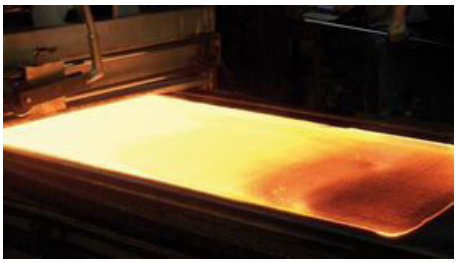


Figure 4.5 Sheet of glass formed from rollers. (Lamberts, 2009)

Figure 4.6 Colour sheets of glass formed from rollers. (Lamberts, 2009)

Figure 4.7 Molten Glass

The Medium

Glass

The term “Glass” is used to describe the hard, brittle, non-crystalline, transparent, vitreous substance which develops from heating sand (silica), potash, and soda (alkali) with lime at 1500^{0}C.

The mixture dissolves until it transforms into a molten mass of glass. The molten liquid is a soft texture and can be manipulated. The significant attribute of glass is its transparency. When gradually heated, the glass softens and when hot it is flexible and can be cut, welded, shaped, drawn or pressed (Marson, n.d.).

The Glass Recycling Process

Recycling glass has been common practice for as long as glass has been in use. Glass that has been collected for recycling is known as 'cullet'. Cullet dumps often comprise broken vessels and windows, and scraps of glass working waste (Jones, 2011). Glassmakers added cullet to a batch of raw materials or frit to help these dissolve and speed up the melting process. Cullet melts at a lower temperature and therefore reduces emissions and saves energy (Consol, 2014). When using cullet it is important to separate and to sorted it by type, for example to avoid contaminating colourless glass with coloured cullet (Jones, 2011). Today cullet or recovered glass is obtained from recycling centres and bottle banks.

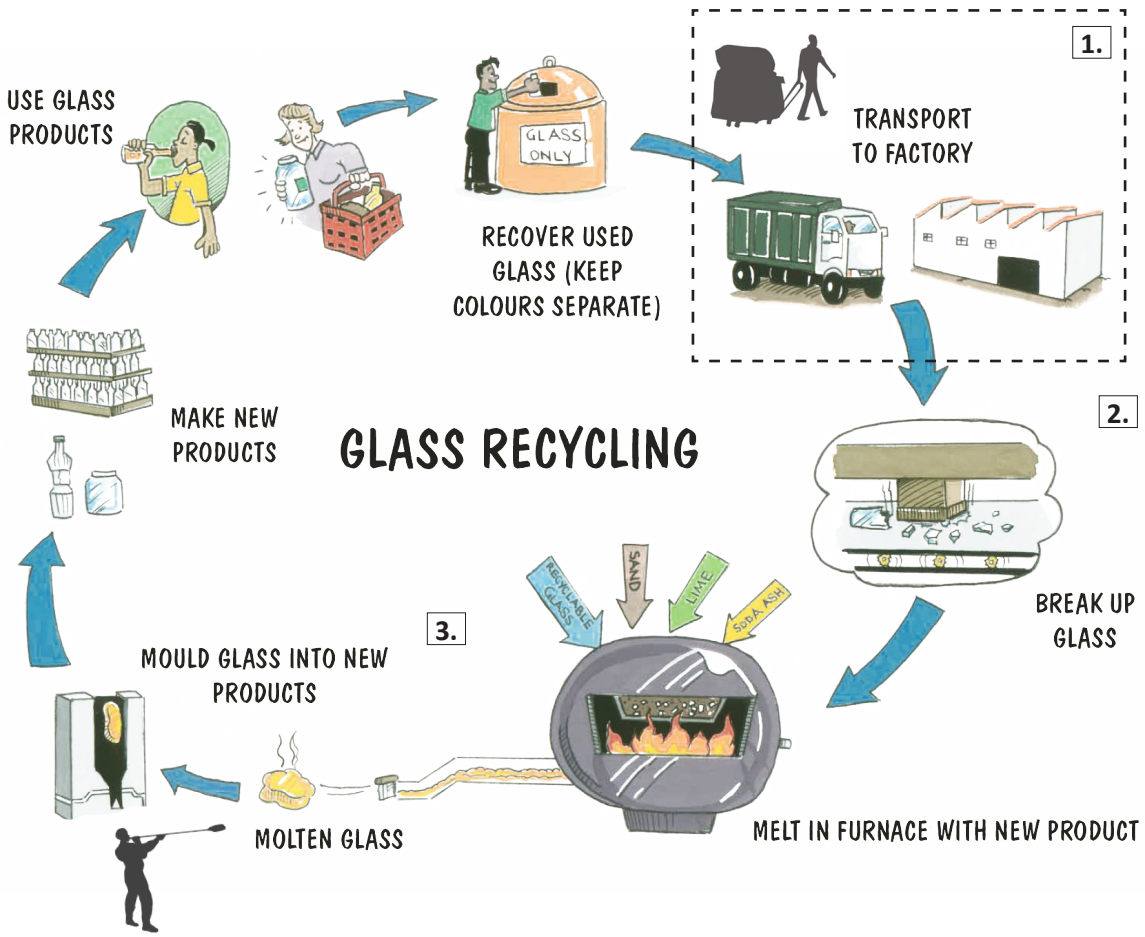


Figure 4.8 The Glass Recycling Process (Matjokana et al., 2005) with additions by author.

Glass Collection - connecting to the source

In order to fully understand the capabilities of waste collection with trolleys. Zama City Waste was approached to assist with this investigation. A single GPS device was used during this investigation and it was rotated between a sample of three waste reclaimers. One rotation was during a two week period where an individual would be tracked and the data of route and distance covered was recorded by Trovano Technologies. The weight of the waste collected was recorded by the owner of Zama City waste. The results of this investigation are as follows:

Weight transported per week

Motete	Khojane	Lefu
1000 kg	560 kg	908 kg

Ave. weight per trolley:

- 5 day week = **820 kg**
- per day = **164kg**

The potential for glass collection per trolley is as follows:

Approx.
68 windscreens per week

Approx.
1100 glass bottles per week

This investigation reveals that although trucks might be able to transport large amounts of waste it is very costly to maintain. The trolleys offer a cheaper and more environmentally friendly option. It also provides more job opportunities.

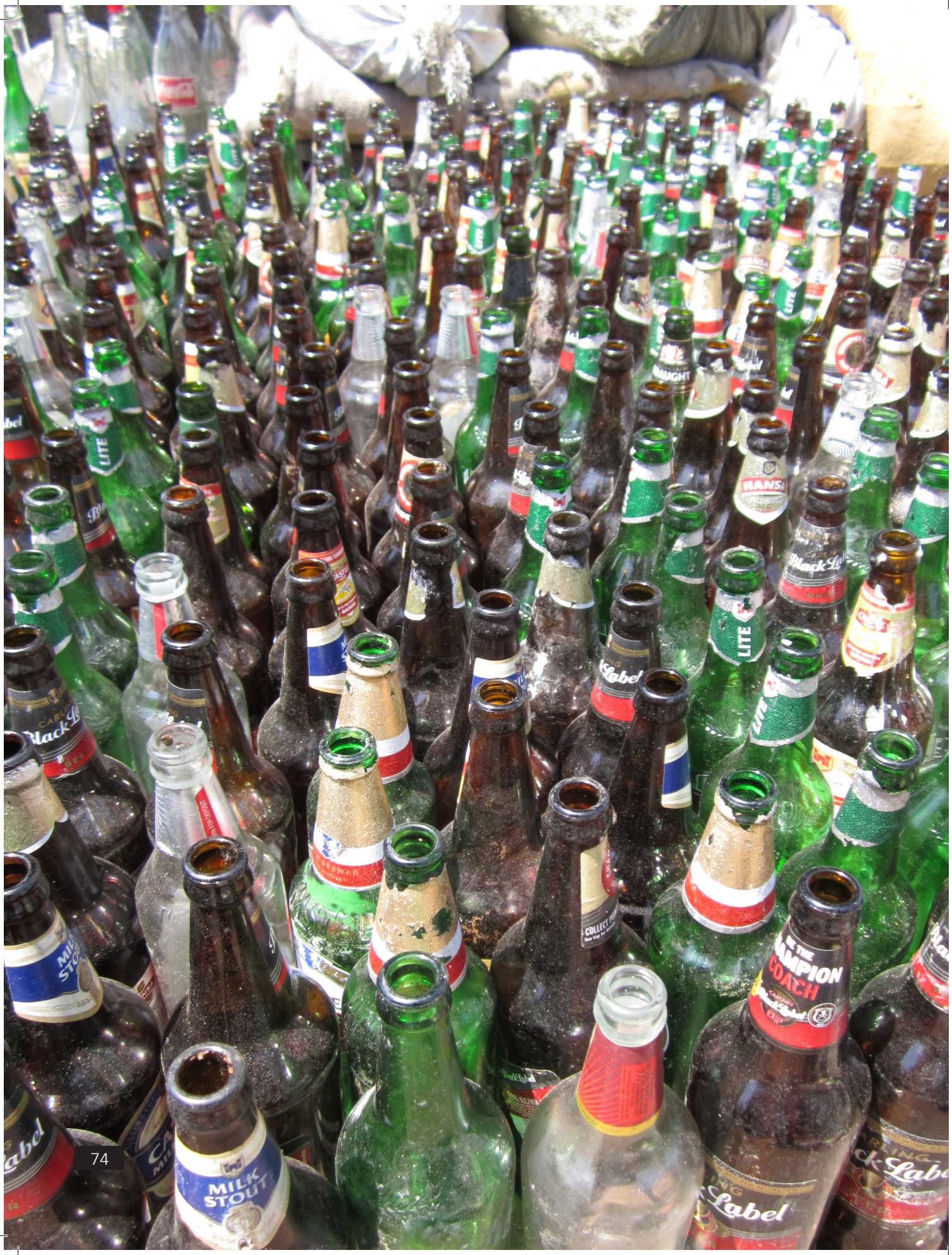
a. Glass Cullet = 1.615g per cm^3 (Auqa-Calc, 2014)
b. $6m^3$ waste removal skip x 1.615g per cm^3 = 9600kg of glass cullet)
c. Calculation: 164kg per trolley x 59 = 9676kg of glass cullet)

Traditional Modes of transport

- 9600kg of glass cullet per day [b]
- Job creation = 2 people
- High running costs - vehicle maintenance and fuel

Unconventional Modes of transport

- 164kg of glass cullet per day
- Job creation = 58 people [c]
- Low running costs - repairs to trolleys and wheel replacement.
- Fuel = Food and water for operators.


LITE
HANSA
Black Label
MILK STOUT
Label

The impact of recycling glass...

"one glass bottle will save enough electricity to use a lamp for one hour

ten glass bottles will save enough electricity to watch TV for 40 minutes

30 tons of glass will save enough electricity to power a suburb during peak hours (5pm-9pm)

If everyone in the country recycled one bottle a month for a year it would save enough electricity to light up Johannesburg for an evening during peak hours (5pm-9pm)"

The Glass Recycling Company 2014

Figure 4.9 Collection of Glass Bottles for recycling

Glass Recycling Process - sorting and crushing into cullet

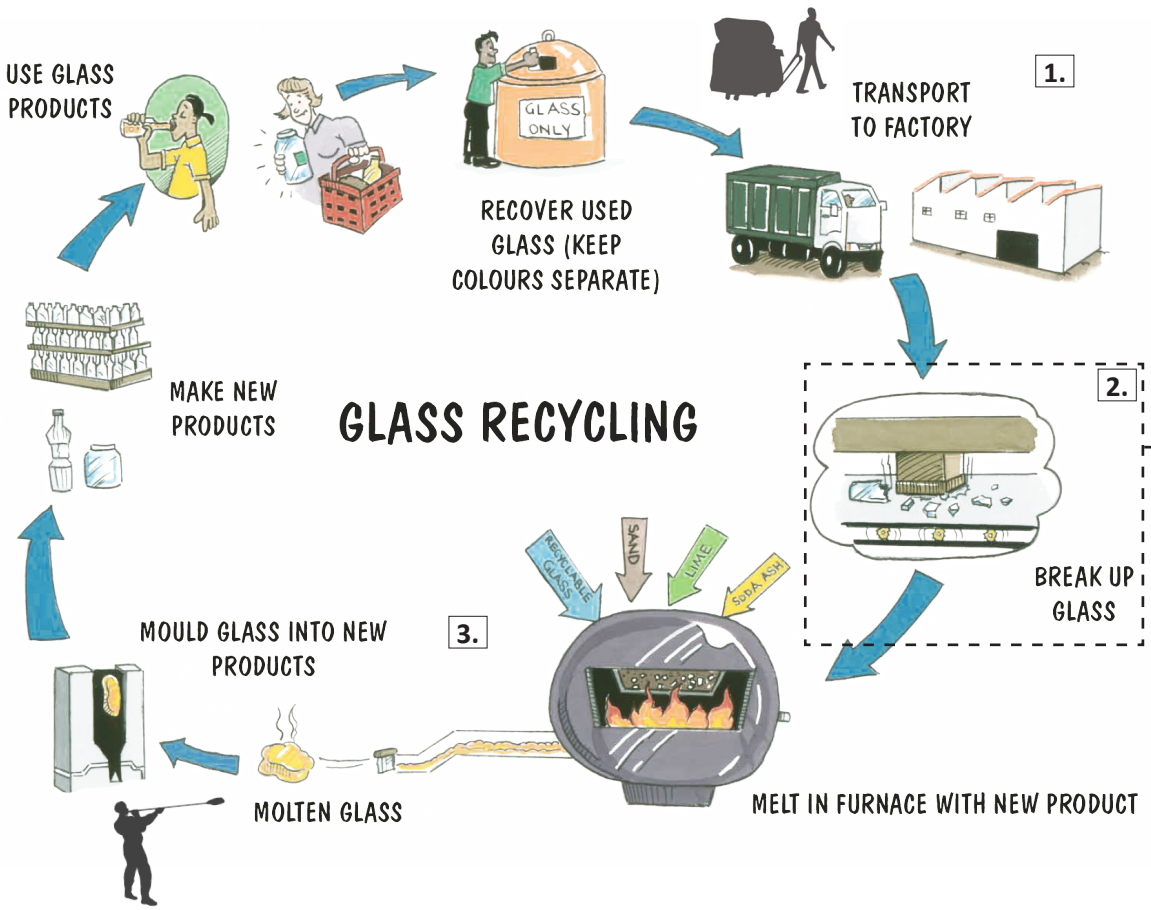


Figure 4.8 The Glass Recycling Process (Matjokana et al., 2005) with additions by author.

Windscreen Recycling Process

Fig 4.10 - Example of how broken windscreens are stored and transported

Fig 4.11 - Windscreen crusher (Andela,2012)

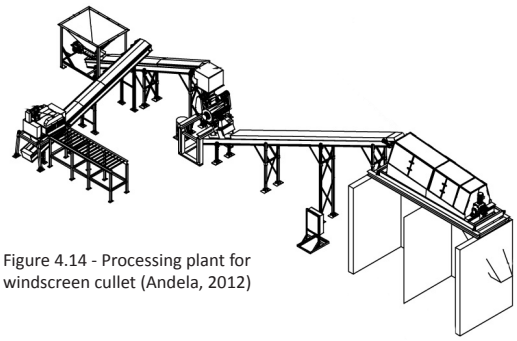


Figure 4.14 - Processing plant for windscreen cullet (Andela, 2012)

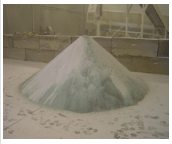


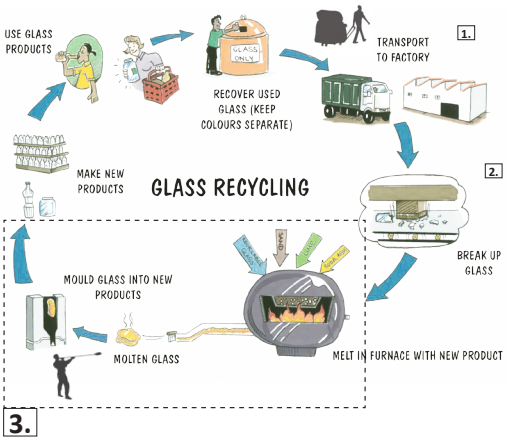
Fig 4.12 - Glass Cullet

Fig 4.13 - PVB laminated film seperated during crushing process

Glass Bottle/Containers Recycling Process

Figure 4.15- Glass bottle seperation process. Images: coutesy of the Glass Recycling Company

Figure 4.16 - Processing plant for windscreen cullet (Andela, 2012)



Glass Recycling Process - transformation

Furnace

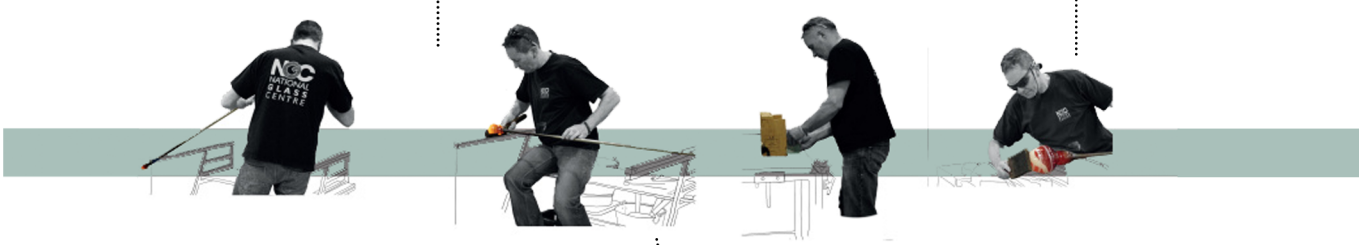
Contains molten Glass
Electricity 110Kw 1600^{0}C

Heat Shield

Steel Frame and wood panel used to shield heat from the furnace

The Glory Hole

Max Temp 1350 C
Used to keep molten glass malleable when shaping



blow pipe preheated and then dipped in the molten glass. This is called 'a gather'

A block of wood soaked in water is used to initially shape the glass.

Patterns can be created in several ways. It can either be rolled in a thin metal sheet or on frit (larger pieces of coloured glass)

A wood paddle is used to create a flat area or base

Yolkroller

used to hold pipes while heating them

Bench

Steel frame and wood infill bench - used when shaping molten glass by hand with general tools close at hand on the bench

Figure 4.17 - The Process of Glass Blowing (Daisy, 2012).

Raw Material

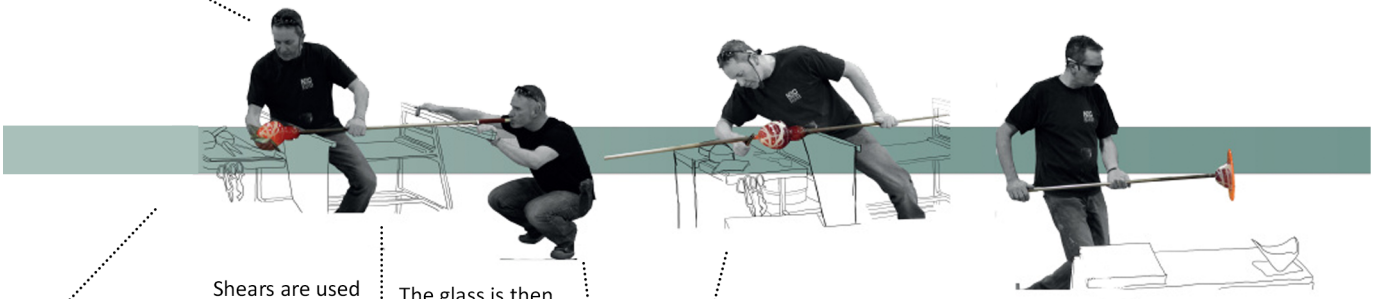
Silicon Dioxide (Sand)

Calcium Oxide (Lime)

Sodium Dioxide (Soda Ash)

Element for added colour or texture

Recycled Glass



Shears are used to pick out detail or a handle for a vase for example

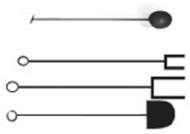
The glass is then attached to a piece of stainless steel to allow work to be done on the opening

Once the opening has been made it is then spun to create a dish

The Annealer

The completed object is placed in the Annealer to set by lowering temperature of the glass at a constant rate. Electricity 16Kw

Pastcarr and Tools



Pipe Turner

supports pipe while blowing the glass into a desired shape

The Client and Users

The envisioned client is a Primary Co-Operative comprising primarily of Waste Reclaimers. It will also include members who have experience in the processing and production of glass as well as restaurant and events co-ordination.

The department of Trade and Industry (DTI) defines a primary Co-Operative as an autonomous association of persons united voluntarily to meet their common economic, social and cultural needs and aspirations, through a jointly owned and democratically controlled enterprise.

The two characteristics, which differentiate Co-Operatives from other enterprises, is that firstly they are associations of people which agree to be the owners, the makers of democratic decisions and the users of their joint enterprise. Secondly, their main purpose, as an economic unit, is to promote their members by rendering services, rather than maximizing profits.

The Co-Operative will be structured as follows (Figure 4.18):
Co-Operative Board who will be responsible for the administrative tasks the Glass Recycling Factory and making decisions with regard to running of the Co-Operative. The board is responsible to liaise and consult with the three operational divisions of the Co-Operative of the Glass Recycling factory, namely the Collection, Processing and Production, Retail and Exhibition Divisions. The board is also responsible for obtaining funding of governments grants and obtaining business contracts of service. The board develop a governance structure and Memorandum of understanding (MOU) defining the relationship between Co-Operatives, Pikitup, and end buyers.

The three operational divisions are responsible for the every-day operations of the Glass Recycling Factory. The aim of the collection division is to collect all recyclable glass from various residential and commercial areas. This will comprise of glass bottles and containers and vehicle windscreens. The Processing and Production division is responsible for the handling of the glass waste collected. They receive recyclable waste from the collection division as well as the local municipality, Pikitup, through the MOU between the Co-Operative and the local municipality. Waste will also be obtained from vendors and private waste management companies. They are also responsible for payment to these stakeholders. The glass is then separated and crushed into cullet. The cullet is used for glass blowing on the premises and the excess glass cullet is then sold to major glass manufacturing companies in the area, namely, Consol, Nampak and PFG Building Glass. (Figure 4.19)

The Retail and Exhibition Art division is responsible for the sale of the glass products produced by the Glass Production Centre to local and international customers. They will also be responsible for organizing glass blowing workshops and various art exhibitions. The restaurant/café associated with the glass exhibition will be run by these members. (Figure 4.19)

The envisioned users will be the general public, local and international. The programme of the building allows for an education component to run through it. The process will be visible from collection to creation of glass products. This allows for tours for both schools and the general public. It will also provide classes to the general public to acquire the age old technique of glass blowing.

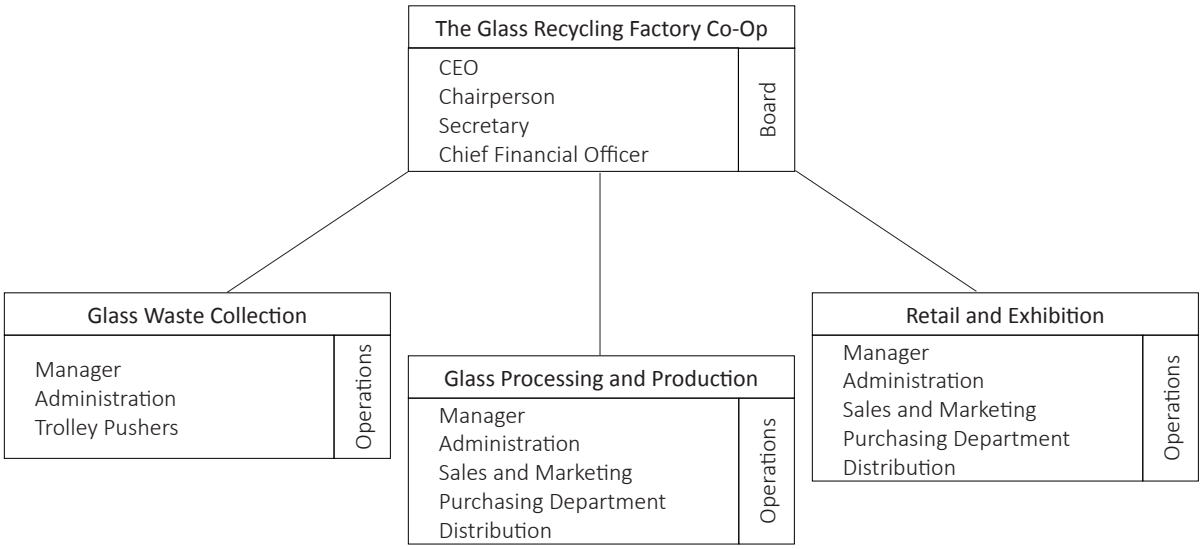


Figure 4.18 - The Glass Recycling Factory Co-Operative Organisation Structure

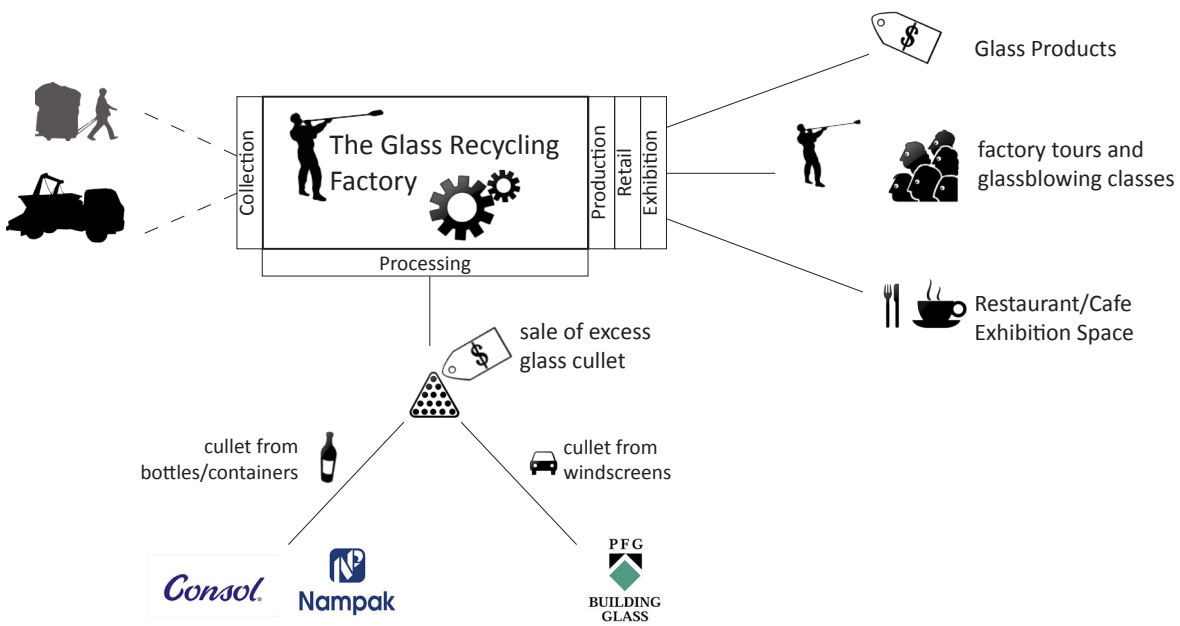


Figure 4.19 - Operations diagram

Making the project a reality through a Public-Private Partnership

The founding members will have different socio-economic backgrounds these will range from Waste Reclaimers to mangers with managerial experience. This mix will ensure personal economic growth through peer learning. All the members will be actively involved in the business.

The proposed site for The Glass Factory has been located in Newtown. Part of this site is currently the Metro Bus Depot owned by the city of Johannesburg. This site has been selected within the city as it is central to recycling vendors from all around Johannesburg. The central business district also offers a wide variety of businesses which recyclable glass waste can be collected. Due to the site being owned by the city, this provides an opportunity for the The Glass Recycling Factory Co-Operative to enter into a business arrangement with Pikitup. (Figure 4.20)

According to (De Beer, 2013) Pikitup is currently upgrading all of its garden sites to become Buy-back Centres. They are also constructing new Buy-Back Centres which will collect recyclable waste and sell back to recycling mills.

The strategy for these Buy-back Centres is for Pikitup to supply the necessary facilities and then enter into a operations agreement with a selected Co-Operative. This Co-Operative will then be responsible for the operation of this centre. They do not pay rent for this facility and they are responsible for the employment of necessary staff and the payment of salaries.
To achieve this business proposal and to create such a recycling factory will require a public/ private partnership between the factory and Pikitup as well as funding and donations from various organizations. The land and building will be funded by Pikitup. They will also provide the Co-Operative with a memorandum of operation to service the Johannesburg City Centre and select suburbs.

The main glass manufacturing entities in Johannesburg namely, Consol, Nampak and PFG Building glass would be approached for donations in equipment and skills training. PFG also has the means to supply the glass sheets for the factory building as this is one of the products that they manufacture. (Figure 4.20)

The Gauteng Department of Infrastructure will be approached to fund the remaining equipment and machinery required.

The Glass Recycling company is a national organization and an industry representative established by the Department of Environmental Affairs and Tourism (DEAT). “The Company is funded exclusively by the levies paid by the brand owners on every ton of glass purchased from the glass manufacturers. The South African glass manufacturers in turn purchase all glass recovered in South Africa, which is recycled into new glass packaging” (The Glass Recycling Company, 2012). They will therefore provide a vital link to government and the various industry role players. They will also provide the necessary marketing to help further increase public awareness of glass recycling.

Fig 4.20 - Public-Private Partnership

Glass Recycling Factory				
Space			m²	Total Area
Glass Recycling Factory	**PROCESSING & STORAGE**			
	Factory Floor	Receiving		
		~ glass bottles/containers	130	
		~ windscreens	145	
		Processing	1285	
		Product Storage (100m² Silos)	320	
		Trolley Storage (60)	40	
		Despatch	80	
	Security	Entry/Exit	25	
	Administration	Maintenance Manager	15	
		Factory Manager	15	
	Saftey	First Aid	15	
	General Storage	Maintenance/Cleaning	60	
	Change Rooms	Factory Staff	175	
			Sub Total	2305
	ADMINISTRATIVE			
	Administrative	Reception and waitig area	100	
		Meeting Room	30	
		Boardroom Room	40	
		Manager x 4 @ 20m²	80	
		Open Office	200	
			Sub Total	450
	GLASS PRODUCTION			
	Workshops	Glassblowing (Hot Shop)	220	
		Glass Product finishing	126	
		Tourch Working Area	45	
	Artist Studios	3 @ 35m²	105	
	Staff Room	Studios	65	
	General Storage	Supplies and Cleaning	10	
		Art Storage	30	
	Toilets	Studios	22	
			Sub Total	623
Public Interface	**EXHIBITION**			
	Entrance Lobby	Entrance	250	
	Exhibition	Exhibition Space and Storage	495	
		Kitchenette/bar/deliveries	125	
		Glass Blowing Demonstration Area	195	
		Temporary Exhibition	240	
	Glass Shop	Glass Products	115	
	Street Trading	Small handcrafted glass products	75	
	Auditorium	Auditorium, Foyer, Storage & Tech	280	
	Restaurant	Coffee Bar	25	
		Seating Area	155	
		Kitchen and deliveries	105	
	Public Toilets	Restaurant and Exhibition	55	
		Auditorium	75	
		Sub Total		2190
General	Basement Parking	60 Bays and Services	2720	
		Sub Total		2720
			Sub Total	**8288**

Accommodation Schedule for the Glass Recycling Factory

The following accommodation schedule has been established based on the functional programme and the company structure. The factory will have a processing capacity of 18tons a day with three glass bottle crushing units and one windscreen processing and crushing plant. The collection of recyclable waste will be conducted by a team of 60 Waste Reclaimers. The majority of windscreens will be received by vehicle.

Figure 4.21 - Lino Tagliapietra in action

POETIC “PROGRAMME”

“Glass is a wonderful material. Why? because the glass is alive. Even when it is cool, it is still moving. It is connected with fire, it is connected with water, it is so natural. Glass is my life.”

Lino Tagliapietra

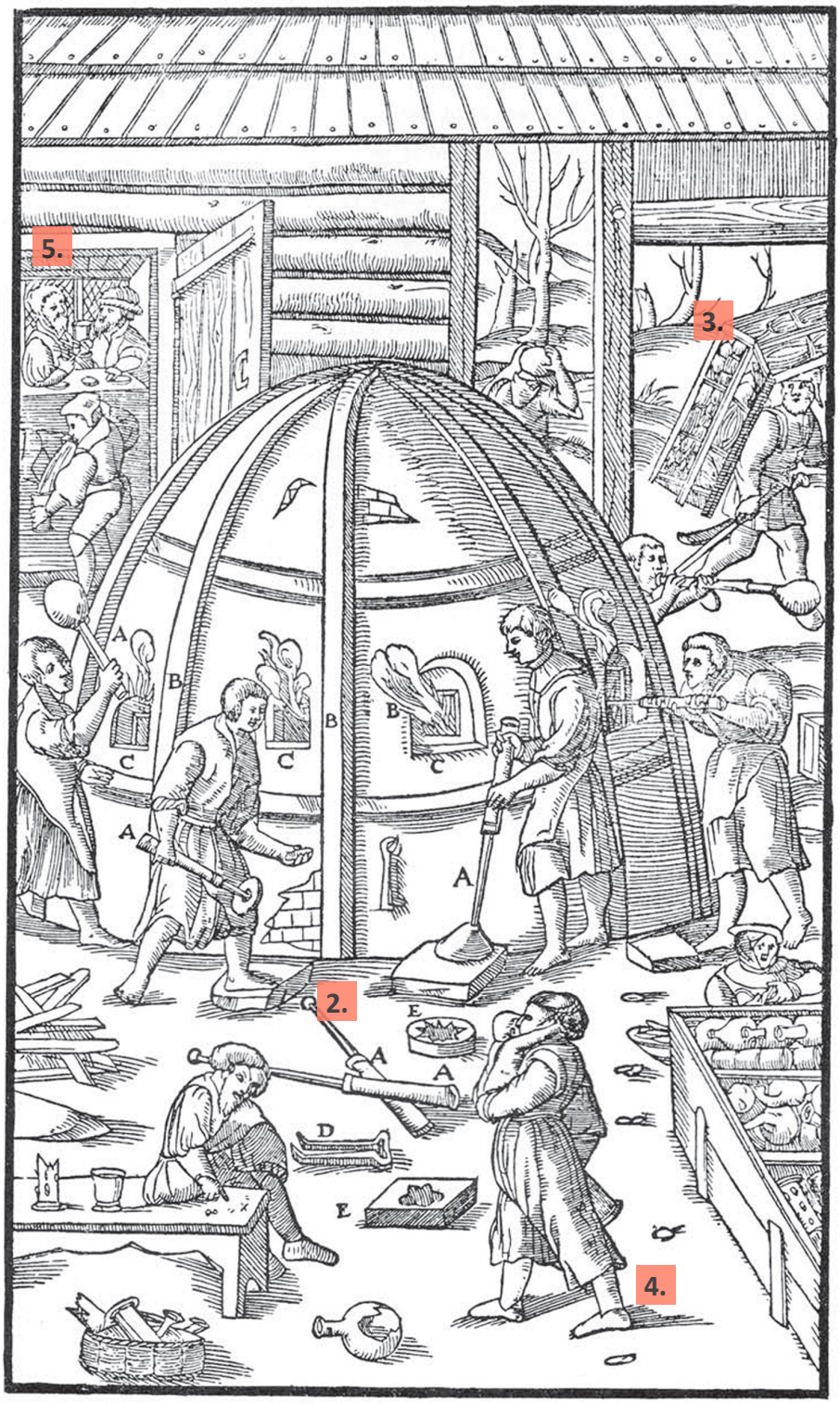


Figure 4.22 - A 16th-century depiction of a glasshouse and workers. (Hoover and Hoover 1950).

Lessons from the past

An analysis and interpretation of an illustration depicting a 16th-century glasshouse.

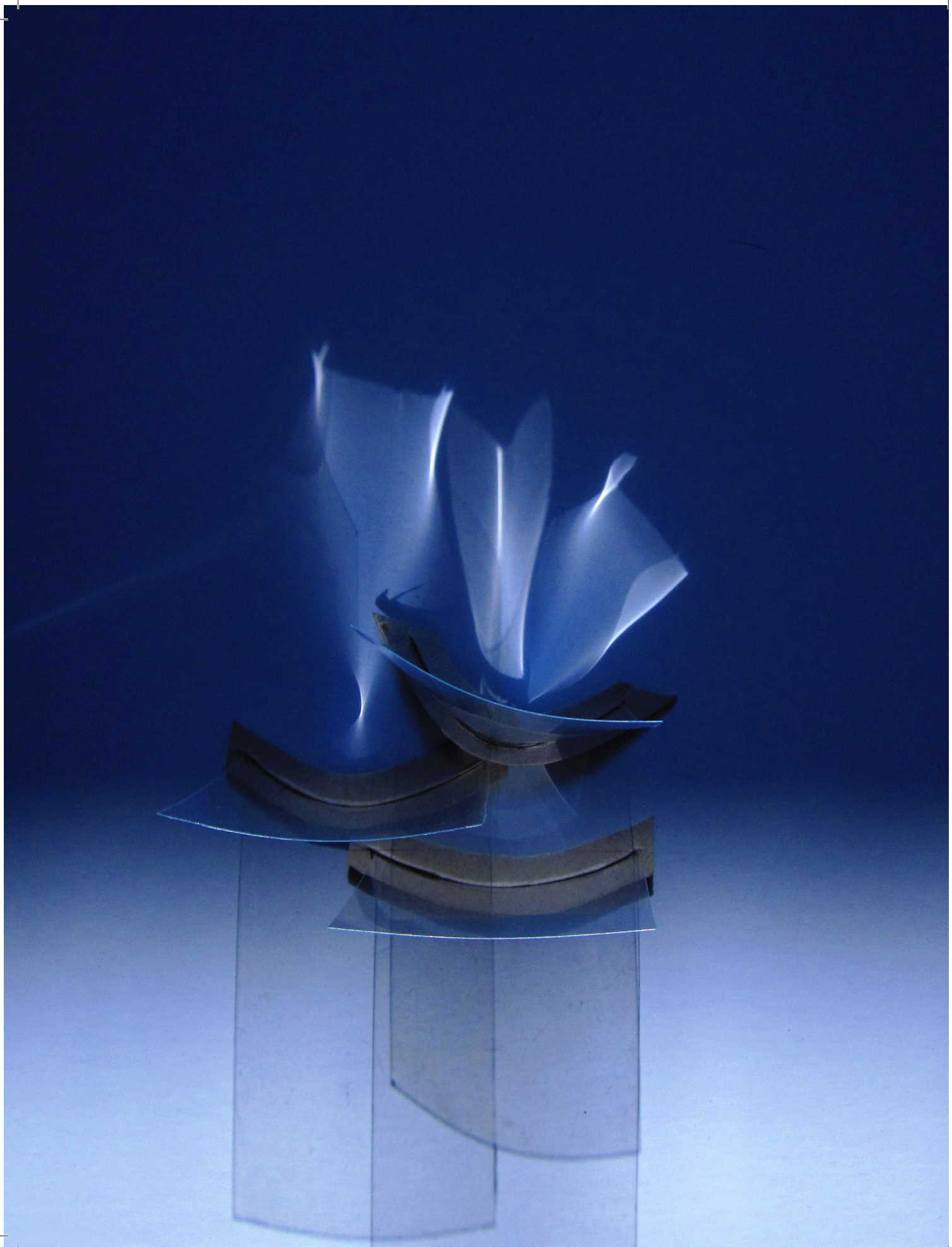
Manufacturing of glass has advanced immensely in the 21st century through technical innovations. This has provided the opportunity for mass production and great precision to provide its consumers with the large amounts of glass products that they demand. However, with the advancement of technology an essence of this age old art form and craftsmanship was lost.

An analysis of the following illustration reveals that there is more than meets the eye when looking back on how glass manufacturing was conducted in a 16th century glasshouse (Figure 4.22). Through literature these illustrations are used to explain the functional aspects of glass blowing and glass manufacturing. This particular illustration was used in the book 'Archaeological Evidence for Glassworking' by Jones to explain the make up of a furnace and the use of moulds for creating glassware when glassblowing (No. 1 +2)

Through a deeper reading of this illustration it becomes evident that there is more than what meets the eye. There is the functional programme of the different processes and activities of glass manufacturing but there is also a poetic experiential "programme." These two programmes are not mutually exclusive but together they create an experiential architecture.

The illustration gives insight into social patterns between people and the relationships between them. It also reveals how this work became a part of everyday life.(No.4+5)The illustration depicts the relationship between the outside activities engaging with the internal process. (No. 3) This has been made possible by the large entrance opening out onto the street and allowing the people passing by to visually experience the process within. It allows for the people within the process to engage and experience the outside and the various activities along the street.
This illustration provides its viewer with an overall experience by revealing the entire process and highlighting the relationship of the functional and poetic programme of a glasshouse.

A primary design intention for the proposed Glass Recycling Factory is for the building to create a dialogue with the people who come into contact with it. The building becomes more than what initially meets the eye from street level. It needs to fuel the publics interest and allow them the opportunity to experience the beauty of this age old industrial process where the manufactured medium becomes a work of art. It will also explore the use of light and glass to create a functional yet experiential industrial building.



“In magnificent spaces light changes and appears to describe form”

Steven Holl

This image reveals how light and glass have the ability to create form. According to Unwin (2003:25), Light is a condition of architecture, but it can also be used as an element. Light can be manipulated by design to identify particular place and to give places a particular character. It is light that gives life to an object. Louis Kahn states that, “Light is the giver of all presences.” Without changing the physical form of a place its character can be radically altered by changing the way in which it is lit. (Unwin, 2003:27) Light can be related to the activity in a place and therefore it can enhance a persons perception and familiarity of that space. These ideas will be explored further within the building design.

Figure 4.23 Light reflecting off glass creating form

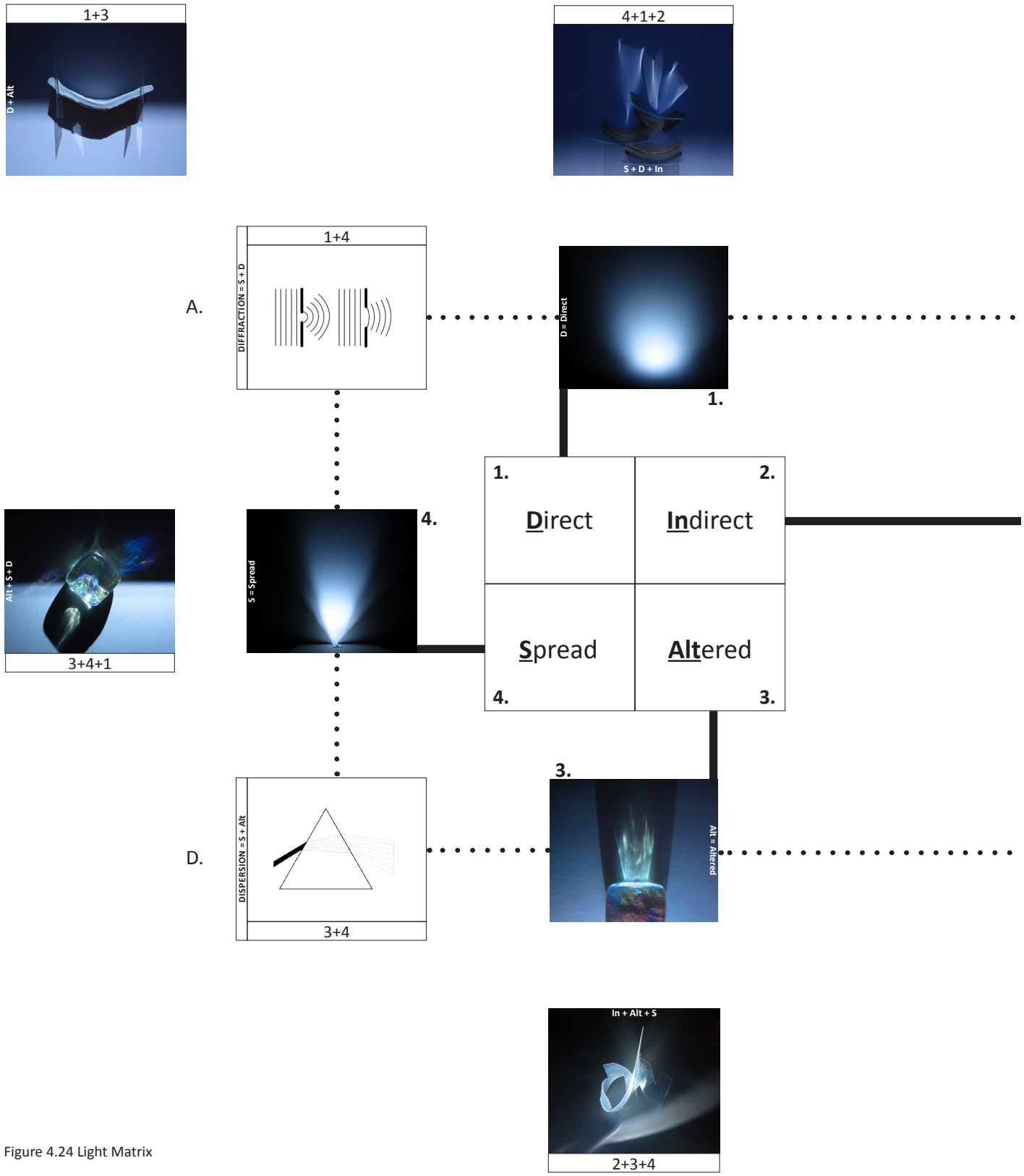
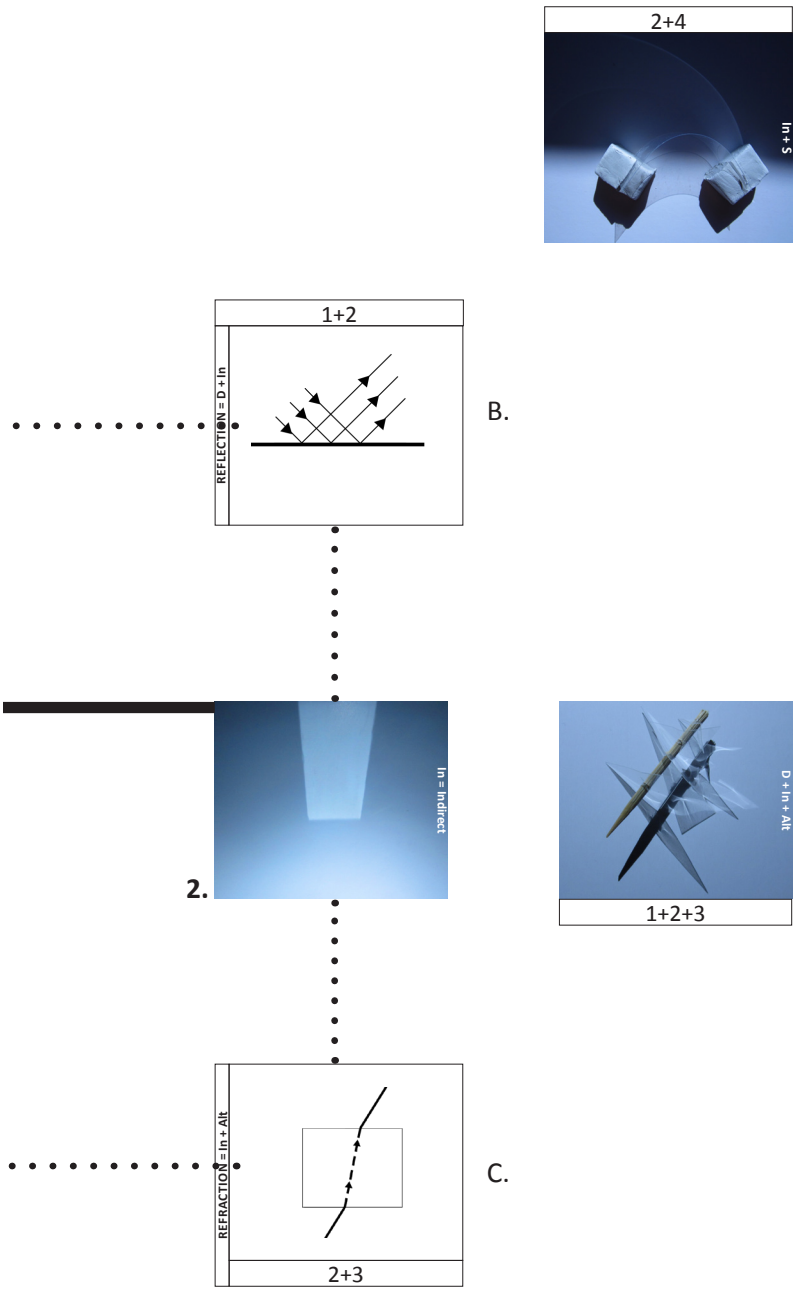


Figure 4.24 Light Matrix

Light Matrix

An exploration of light and glass and its ability to create form



Light waves obey four basic rules (CSIR, 2009):

A. Diffraction
The spreading of a lightwave when passing through a gap.

B. Reflection
When a ray of light reflects (bounces) off a surface. It reflects the ray of light at the same angle as it initially hit the surface.

C. Refraction
The change in direction and speed of a light wave as it crosses boundaries between mediums.

D. Dispersion
This splitting of light into its components (revealing colours) due to refraction.

The Light matrix is an investigation to explore the different qualities of light when reacting with translucent mediums. Acetate film as well as glass were used in this investigation. The matrix is numbered to explain the different combinations of light and the different qualities which result from those combinations.

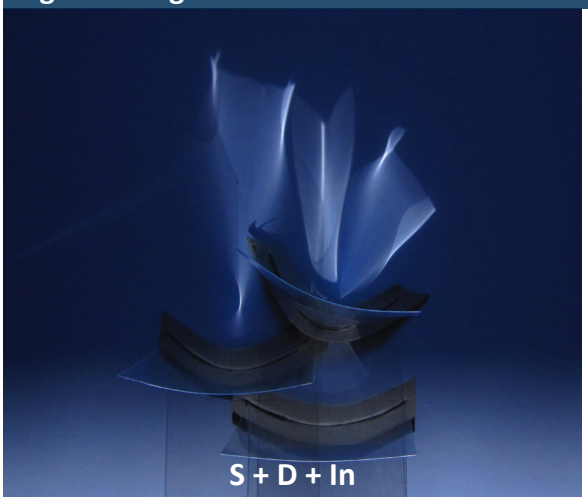
The four basic properties of light as defined above, were further broken down into properties named direct light, Indirect light, Altered light and Spread Light.

The investigation has provided a means of further understanding how light reacts with a transparent medium (glass) and how it can be manipulated to further enhance a space within a building.

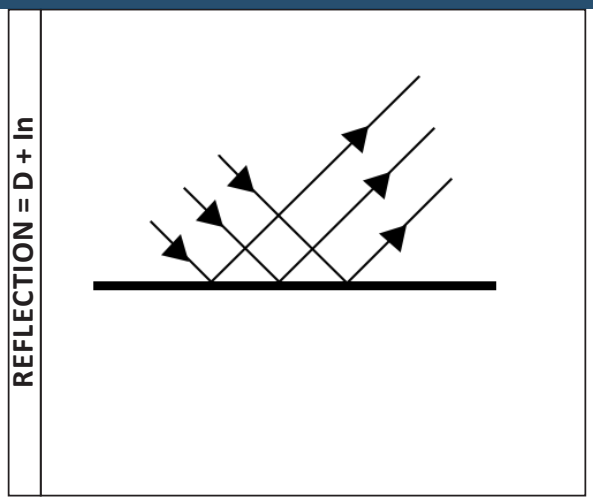
Application of the Matrix

The following light condition will be explored within the building design to enhance the experiential “programme” of the building to create a space of function and experience.

Light Strategies



Strategy 1: Bent Light



Strategy 2: Reflected and Filtered Light

Possible applications

Fig 4.25 - Saint Pierre church, Firminy designed by Le Corbusier (Waker, 2013).

This light enhances a space of spiritual gathering and learning.

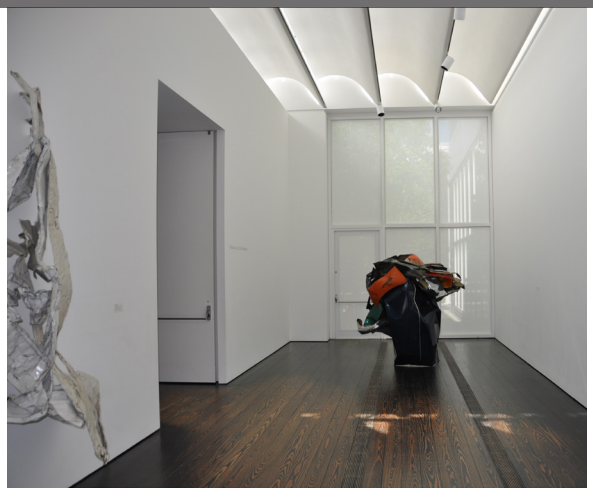
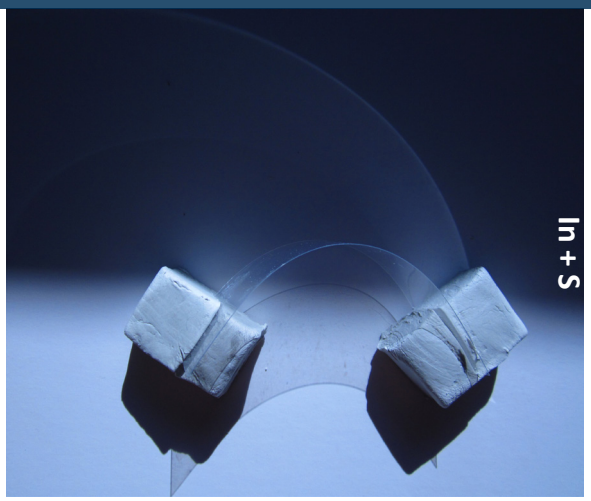


Fig 4.26 - Menil Collection designed by Renzo Piano (Gianakos, 2011)

This light emphasizes a space of pause



Strategy 3: Scooped Light

Strategy 4: South Light

Figure 4.27 - The Nelson-Atkins Museum of Art designed by Steven Holl Architects (Ryan, 2008).

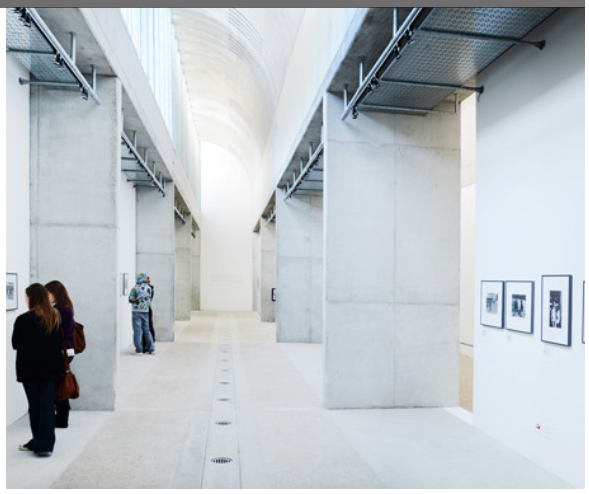


Figure 4.28- Red Location Cultural Precinct Art Gallery designed by Noero Wolff Architects (Eicker, 2012)

This light emphasizes a space of fluidity and movement

This light creates an atmosphere for learning and creativity.

05 |

PRECEDENT STUDIES

The exploration of the following precedents give insight into the different components that together help develop a building that creates a place of meaning through the interaction with its users and the surrounding environment. The idea of light as a medium will be explored to shed light on its meaning within this thesis. Functional space will be investigated to understand its sense of place and meaning within the realm of industrial architecture. Lastly, the idea of system and regeneration will be explored.

The Nelson-Atkins Museum of Art (Kansas City, Missouri)
Steven Holl Architects

The Nelson-Atkins Museum of Art building communicates how light can be introduced into a building using a steel framed structure and infill that has been strategically designed to capture light and utilize it as a medium to sculpt and form space within the structure. Through this design an experiential architecture has been achieved.

An interesting observation is that the exterior of the building although it also comprises of a framed structure and cladding is different to the interior of the building. The difference occurs through the different utilization of cladding material and structural detail. The exterior of the building communicates a simple light weight structure, perceive to have a large open spaces internally that is flooded with natural light. However, within the building the cladding of the steel structure is strategically designed to allow a certain amount of daylight in and the quality of light is therefore altered by the structure itself. The spaces within the interior are sculpted and the forms enhanced by the light.

The skin (cladding) of the building creates a threshold which allows different conditions to be experienced. The skin of the building can therefore be used to create and enhance the experiential aspect of a building.

Figure 5.1 - Nelson-Atkins Museum (Ryan, 2008).

“Entering a room through windows in the wall plane, or through skylights in the roof plane overhead, the sun’s light falls on surfaces within a room, enlivens their colours and articulates their textures. With the changing patterns of light and shade that it creates, the sun animates the space of the room, and articulates the forms within it. By its intensity and distribution within the room, the suns light can clarify the form of the space or distort it; it can create a festive atmosphere within or instill within it a peaceful mood” (Ching, 1979:108).

Figure 5.2 - Internal View (Ryan, 2008).

Figure 5.3 - Foyer Space (Ryan, 2008).

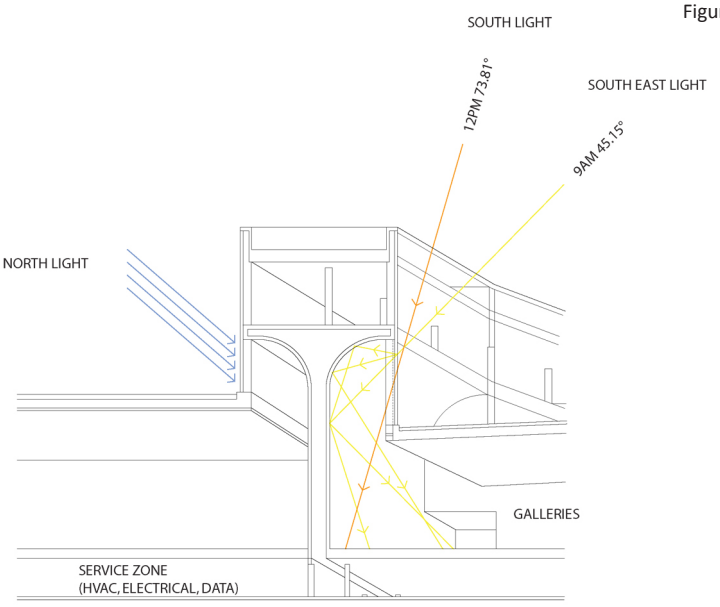


Figure 5.4 - Structural Detail of the building showing how daylight enters the building (Ryan, 2008).

The Process of transformation

The search for industrial exhibition through a comparison of building technology

Through a comparison of structural forms and their ability to create meaning for the user and activity. A contrast will be drawn to orientate the industrial process of glass recycling and the art of glass blowing production to form an identity within the realm of process and exhibition.

Light weight structures were designed to cater for the need to house large equipment for industrial sector. These light weight structures provided a fast and economical means to construct buildings. This technique of building used steel frames with infill of brick, timber or sheet metal with an exterior cladding of similar materials.

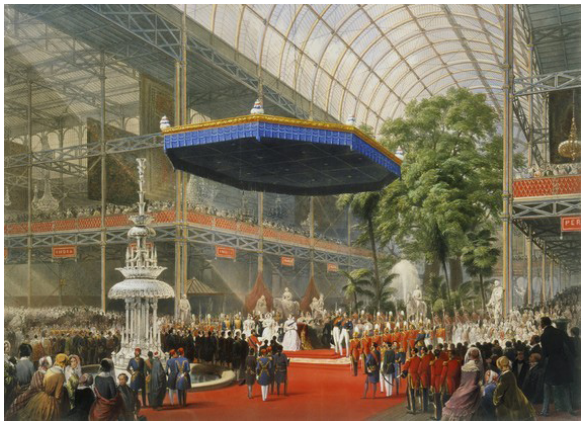


Figure 5.5 - Interior View of the Crystal Palace

Figure 5.6 - Exterior View of the Toledo Museum (Basulto, 2010)

If one looks at the industrial shed it provides a functional space for a certain industrial process to occur. In the case of the glass blowing company, The Crucible in Benoni, Johannesburg. A standard structural portal framed shed is adopted to house the glass blowing company. Within this shed the spaces have been arranged to suit its process and within theses space the artist finds meaning and connection. This is an example of a typical large span structure which is associated with industrial activities.

The Crystal Palace challenged the idea and perception of the structural character that is identified with an industrial building type which housed machinery and process. It created an exhibition space with large open spaces allowing for freedom of use and arrangement to house a different activity to that of an industrial process. It took advantage of the technology available and created a space which also allowed daylight to penetrate its structure through the medium of glass. A material that is not associated with the typical construction of a large span structure. The use of this material therefore generates a new perception for a large span structure.

Toledo Glass Museum has like the Crystal Palace disputed the notion of the industrial process with the use of a steel frame structure to create a place of exhibition with the use of advanced technology of sheet glass and steel and concrete to create a place where the industrial process can be exhibited.

The steel frame of a typical large span structure housing an industrial activity has in this case been disputed. The building has indeed used a steel structure however it is not a large span steel structure.

This therefore put into question the perception that an industrial activity should be conducted within a steel framed factory shed.

These precedents therefore communicate that through the different use of a building materials perceptions and associations attached with these built forms can be altered.

Figure 5.7 - Interior view within the steel frame structure

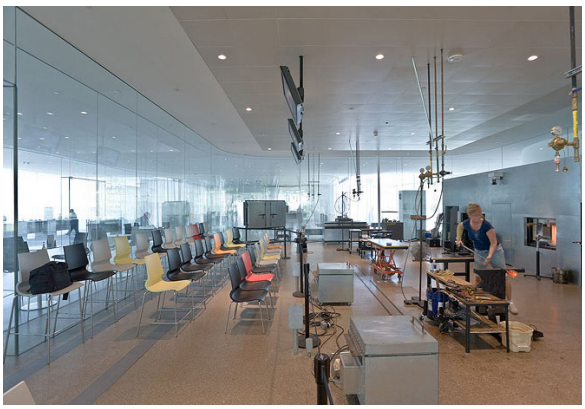


Figure 5.8 - Glass Blowing within the Toledo Museum (Basulto, 2010)

Figure 5.9 - Interior View of the Crystal Palace

Figure 5.10 - Zama City Waste

Zama City Waste (Doornfontein, Johannesburg)

Creating a place of meaning through identification and orientation within a system of waste.

Zama City waste is a privately owned buy back centre. It supports approximately 60 Waste Reclaimers who have each been given designated areas within the open plot of land to store and sort the different recyclable waste that they have collected.

This precedent displays a self-organizing system within the large waste management system within the City of Johannesburg. It may seem to be disorganized however, it functions efficiently with every part (person) contributing to the bigger system of waste management.

This is also an example of a place which provides orientation and identity for the Waste Reclaimers.

It allows for the different Waste Reclaimers lifeworlds to join and connect creating a sense of belonging. It is however limited in terms of expanding the lifeworld of the Waste Reclaimers as it only promotes the activity of collection and sale of recyclable waste. Yes it provides a space to store and sort waste but it fails to create an awareness and an opportunity to become part of the bigger context of the waste management system in which they are participating. Therefore it is important to create opportunities for people to expand their lifeworlds

Figure 5.11 - Zama City Waste Storage

Figure 5.12 - A designated area allocated to two informal waste collectors

Figure 5.13 - Waste Reclaimer

Figure 5.14 - Glass Chapel (Rural Studio 2010)

Glass Chapel (Mason's Bend, Alabama)
Rural Studio

The glass chapel designed and constructed by the Rural Studio is an example of a built structure that has incorporated a simple structure and technology to create something extraordinary using standard materials available.

The building has unusual form however, the design remains true to the nature of the building material. The use of recycled windscreens is of particular importance in this precedent as it is through the use of this medium which creates interest. The glass remains true to its character as it still performs functionally by allowing transparent viewing and protection from the exterior elements. However, this particular form of glass used in this project challenges peoples perception as it has been used in a different application and context as it is normally found. It creates an awareness and an interest in the building.

This therefore reveals a strategy that can be incorporated into the proposed design of the Glass Recycling Factory. The use of glass blown sheets of glass made from recycled glass strategically placed within the building design will assist to create interest and awareness.

Figure 5.15 - Glass Chapel (Rural Studio,2010)

PFG Building Glass (Spings, Johannesburg)

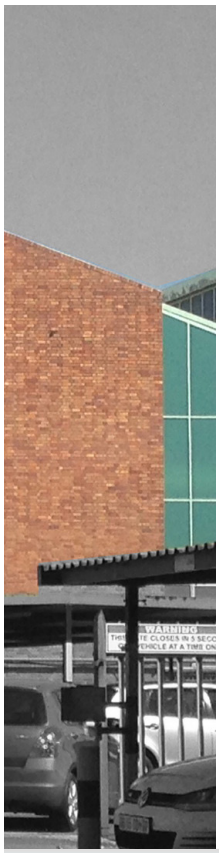
Creating the a vibrant system through the medium of glass.

PFG Building Glass is a leading figure in Africa 's glass industry specializing in glass manufacturing for the building and automotive sectors (PFG Building Glass, 2010).

The PFG factory is based in Springs, Johannesburg. It was founded by Pilkington Bros in the 1950s, with the first drawn sheet glass line commissioned in 1951. PFG currently has two advanced float glass manufacturing lines (PFG Building Glass, 2010). The factory opened a windscreen recovery and reclamation programme in 2006 and expanded its operation in 2011. This programme was set up to recover broken windscreens from various glass operations around the country (D'Oliveira, 2014).

The windscreens are crushed by a dedicated plant removing the laminate, the glass then is broken down further to produce cullet. This is then reused in the glass-making process for new windscreens. (PFG Building Glass, 2010).In 2013 the company recycled 400 000 windscreens (D'Oliveira, 2014).

Figure 5.16 - PFG Building Glass Factory



The PFG windscreen recovery programme provides an example for the possibilities of glass recycling within Johannesburg. This operation has created a vibrant closed looped system which interacts and considers the various activities and participants within the products life-cycle. This has therefore created opportunities for future interaction with small to medium enterprises within the recycling industries. This would align with the proposed project of the glass recycling factory. The factory would assist in windscreen recovery and glass processing to supply PFG with ready to use processed glass cullet.

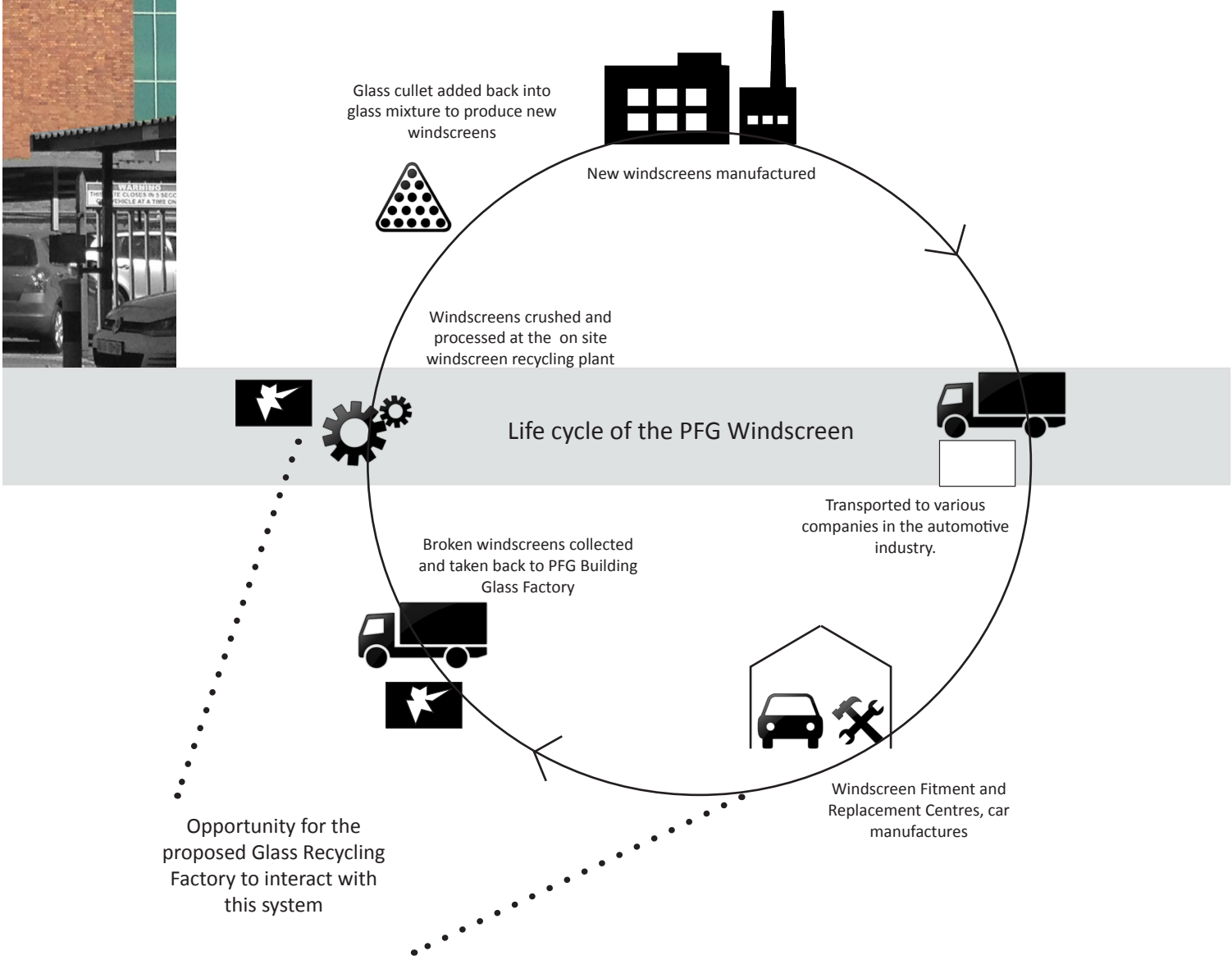


Figure 5.17 - Closed-Loop windscreen recycling diagram

06 |

DESIGN DEVELOPMENT

“Physical clarity cannot be achieved in a form until there is programmatic clarity. This clarity is achieved by understanding the functional origins of the design problem and to find a pattern in them. A design problem is based on two entities namely, the form in question and its context. Form cannot be achieved without the interaction of form and its context (Alexander, 1964:108)”.

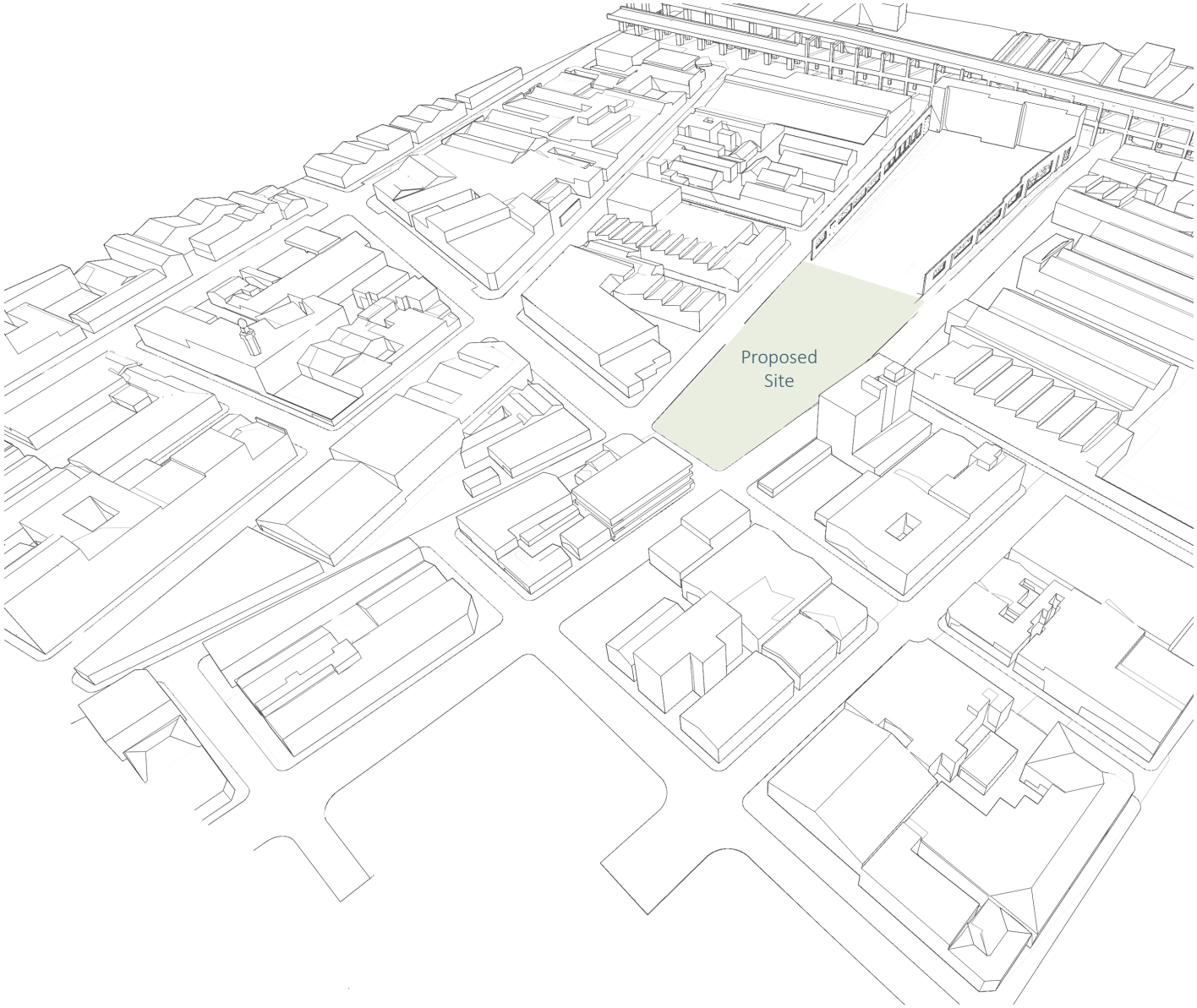
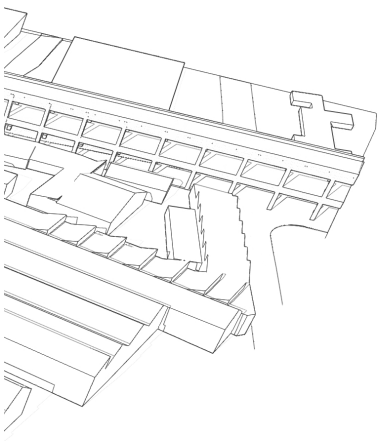
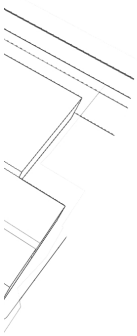


Figure 6.1 - Site Location within existing built form

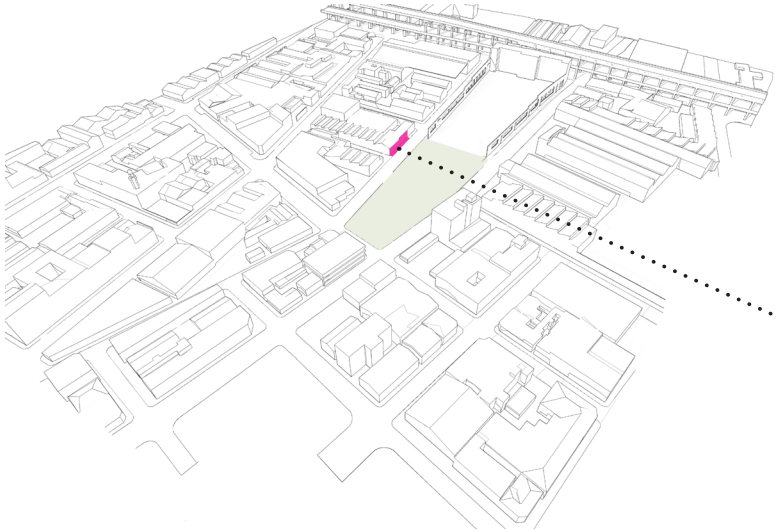
Lessons learnt from the surrounding Context.





The surrounding context provides design informants to assist in designing a building that interacts with its physical surroundings as well as provide a space to enhance the current activities along its streets. The following is a list of informants that will further be explored in the building design:

1. Visibility of process
2. Creating a hierarchy of urban spaces
3. Embrace the character of the street trader
4. Clipping onto a facade
5. Relate to the shops along the street
6. Respond to the character of the street corner
7. Challenging the site boundary

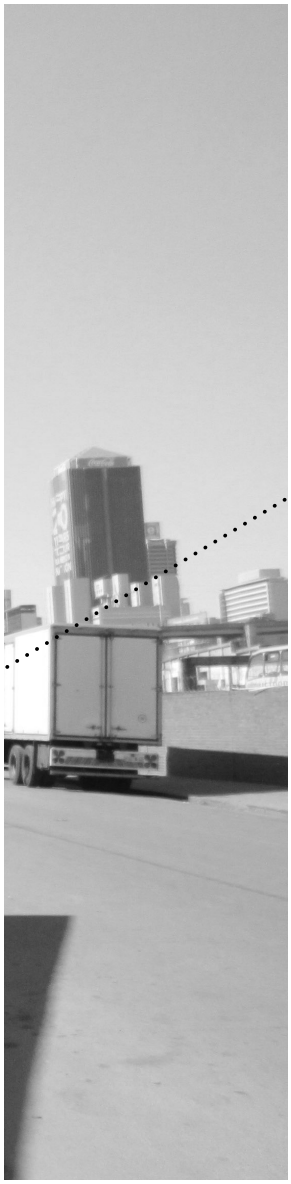


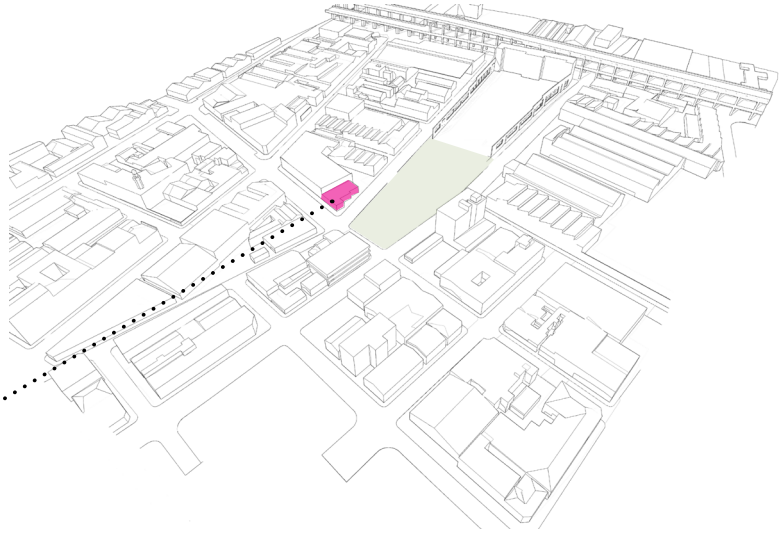
1 Visibility of process

The wholesale warehouse along Barney Simon Rd creates an active street edge with the constant movement of people and wholesale products. People are drawn in either visually as they walk by. This is a good example of how exposing activities within a building creates awareness and interest for people passing by.

Figure 6.2 - Wholesale warehouse

Figure 6.3 - Change in level of street pavement





2 Creating a hierarchy of urban spaces

The building across the street provides an opportunity to enhance the existing urban character. It provides a change in level from the pavement which then leads to shops. There is a courtyard space to the right of this building providing possible opportunities for a restaurants or cafe's. The proposed building needs to take this into account and ensure that the activities placed along this street edge will relate and enhance future interactions.

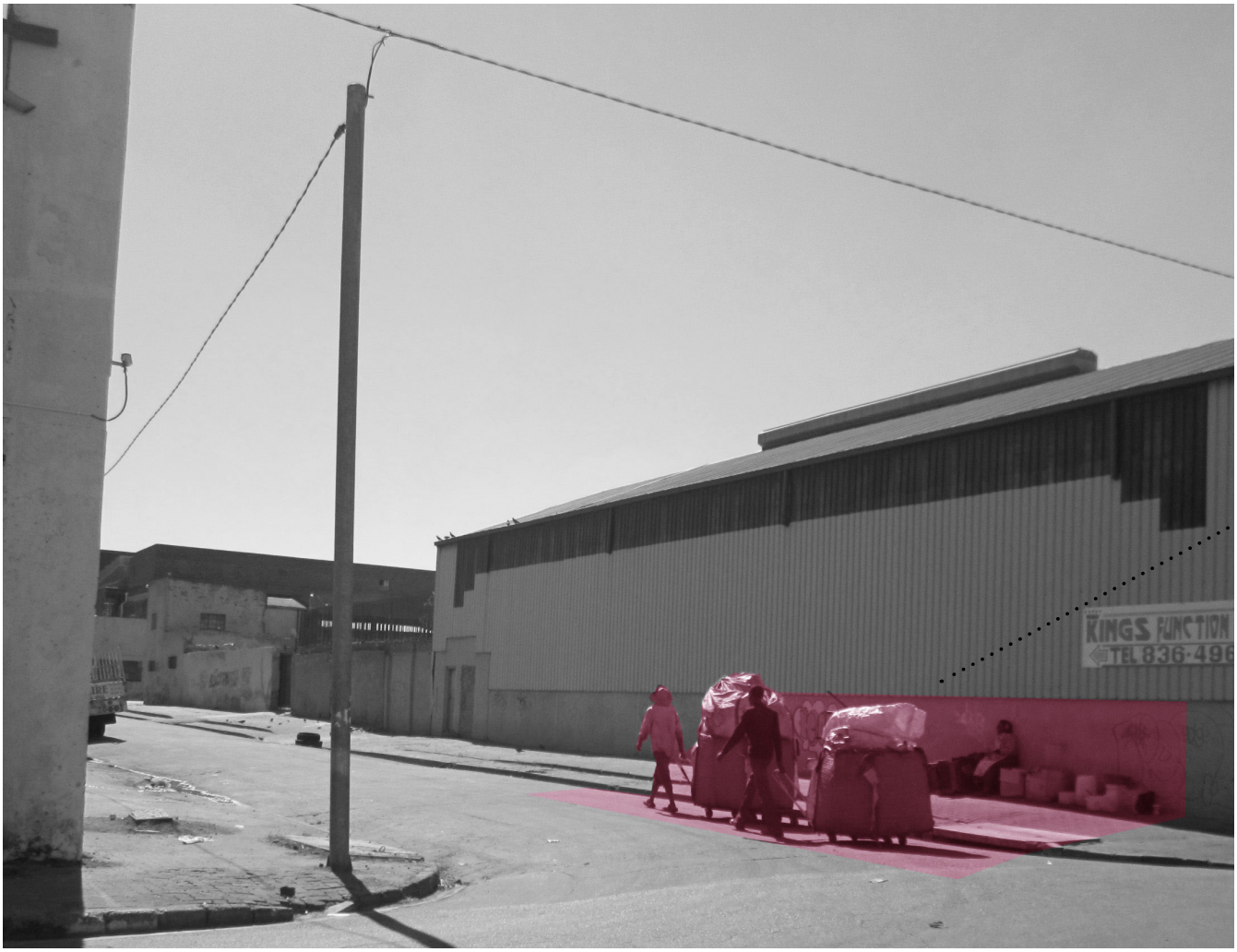
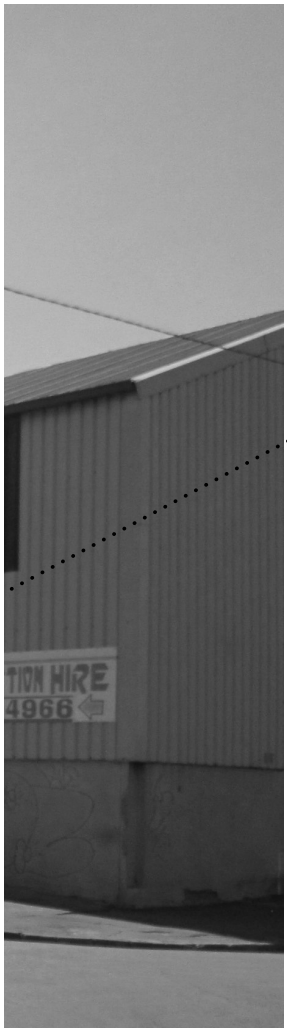
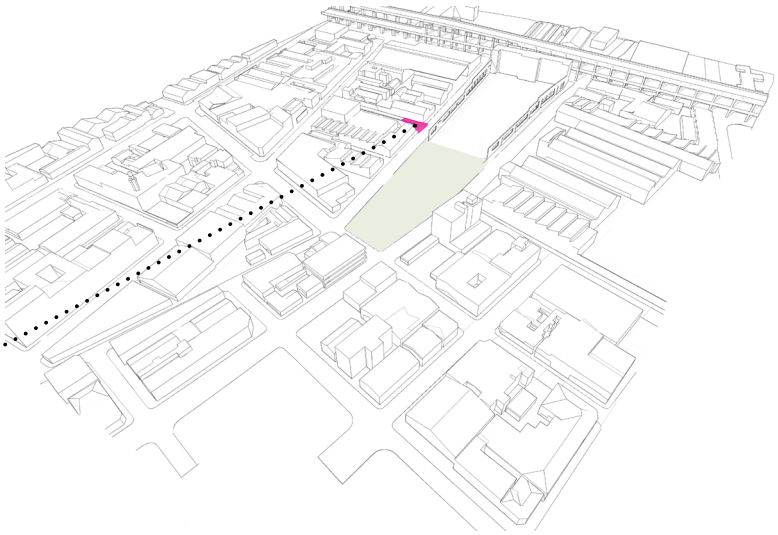


Figure 6.4 - Street Trading





3 Embrace the character of the street trader

There are a number of street traders who set up temporary stores within close proximity to the site. The building design will embrace this and provide a space along the street edge for the sale of glass products made by the craftsman in the glassblowing studios.

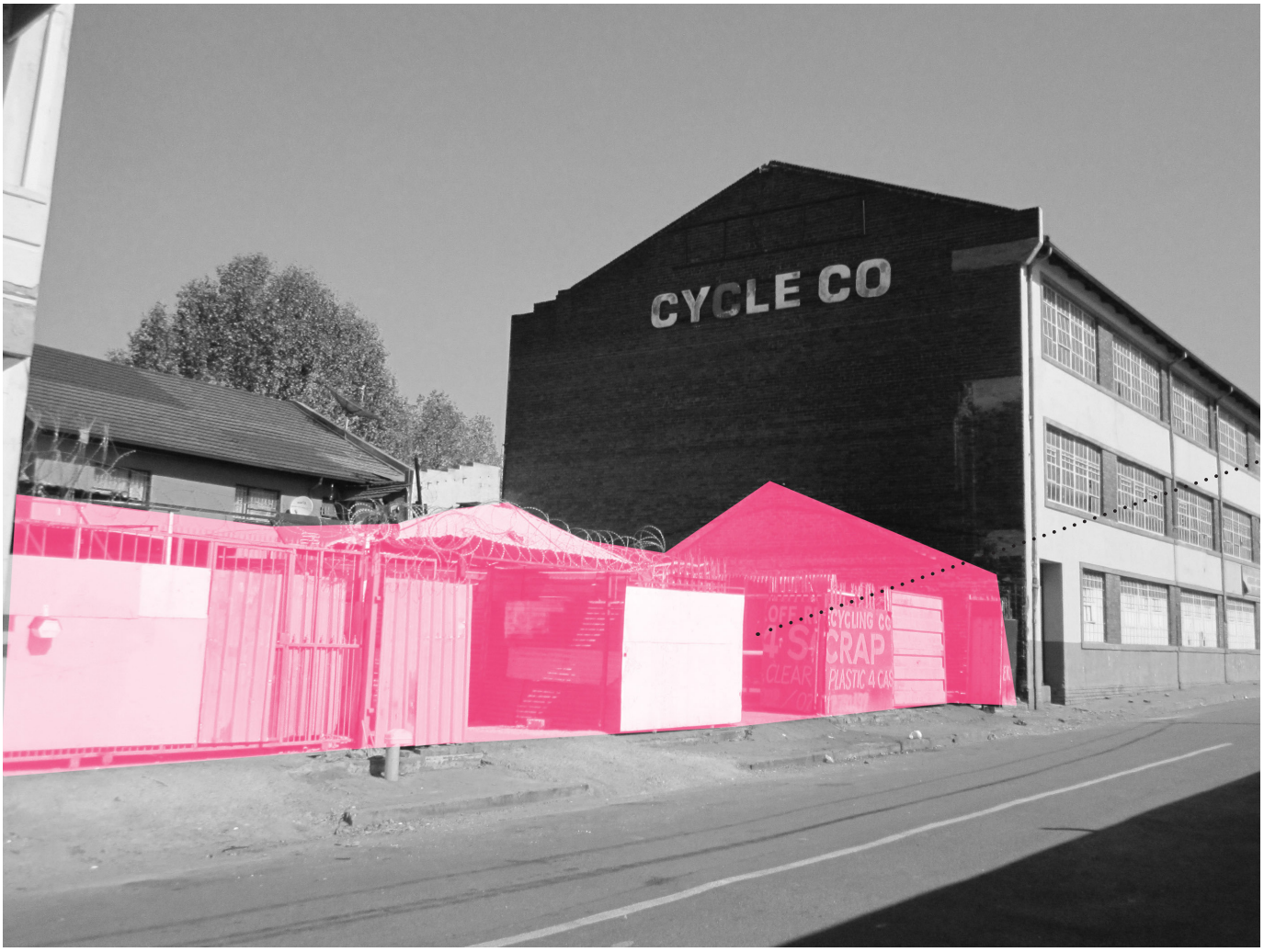
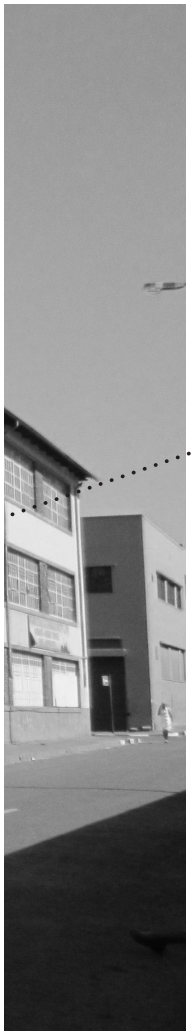
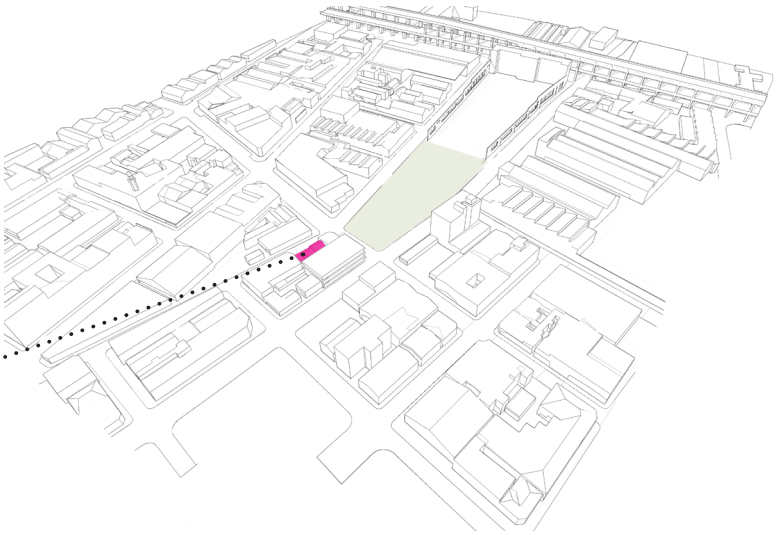


Figure 6.5 - Providing niches off the street





4 Clipping onto a facade

This image displays the use of light weight steel structures attached to a larger permanent structure. These provide a human scale street edge that provides openings along its facade with smaller intimate niche spaces leading off from the street. This street character will be explored in the proposed design.

Figure 6.6 - Quinn Street

5 Relate to the shops across the street

6 Respond to the character of the street corner

The mixed-use buildings along Quinn Street, to the west of the site, provide an opportunity for the building design to connect and enhance the street character. This vibrant street provides an opportunity to display and reveal the glass products and activities within the building creating an awareness and interest in the building. The corner of the site also needs to provide a space of pause to encourage social interaction as is evident in the image above.

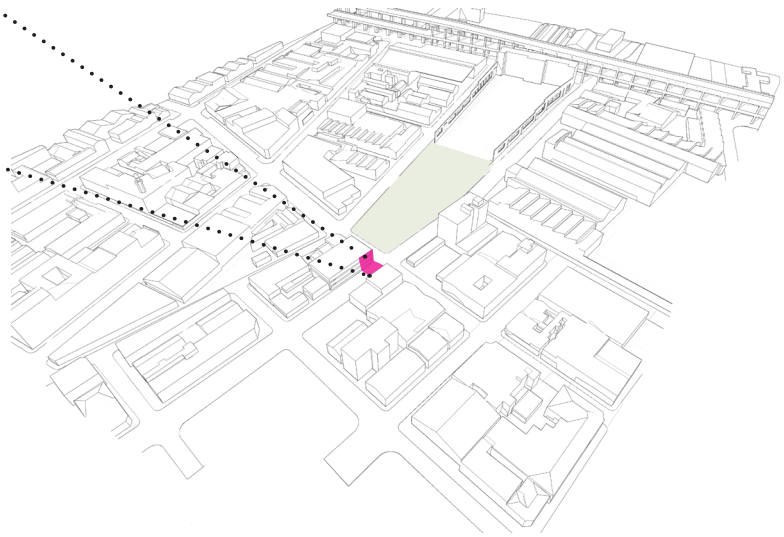
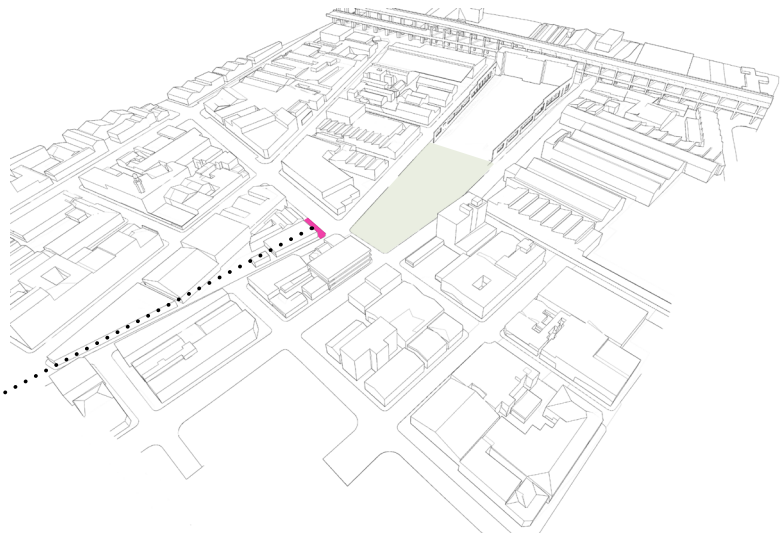


Figure 6.7 - Shop extending onto the street pavement



7 Challenging the site boundary

This shop interacts with its customers along the street pavement. This activity gives the street edge a new character which encourages social interaction . It is also a way of advertising the activities and nature of the shop along this street.

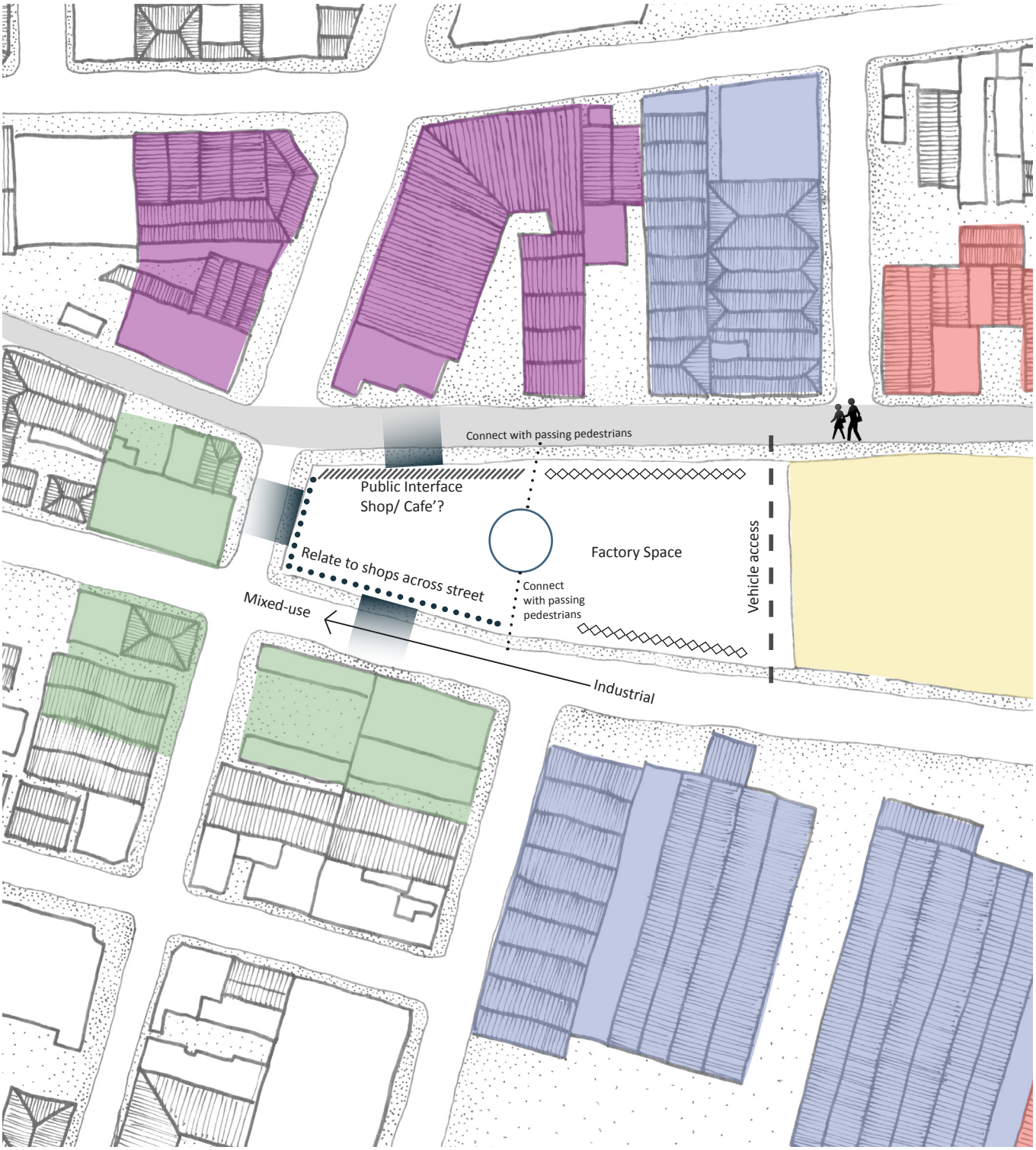


Figure 6. 8 - Responding to the context

Key

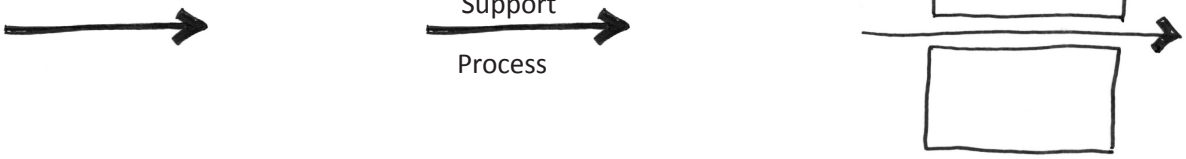
- Mixed shops/offices
- Warehousing/ Wholesale
- Mixed-Use Residential
- Zoned for Housing
- Light Industrial
- Pedestrian Friendly link from Mary Fritzgerald Square to Oriental Plaza (west)

SITE

Light Industrial

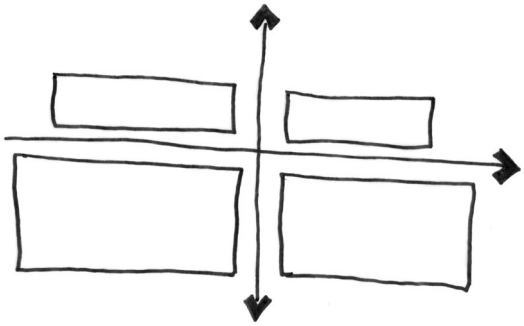
Mixed use retail & residential

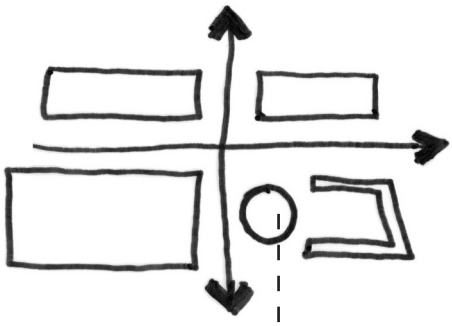
Land use gradient influencing the proposed site



Design Concept

The design explores the concept of transformation.
The idea of transformation is process this is represented by a linear path.
In an industrial process there are spaces of function and support.
This design therefore is arranged along a linear path with adjacent functional and supportive spaces along this path.





This path is then intercepted by the interaction with the city and at the interception of paths is the heart of the building

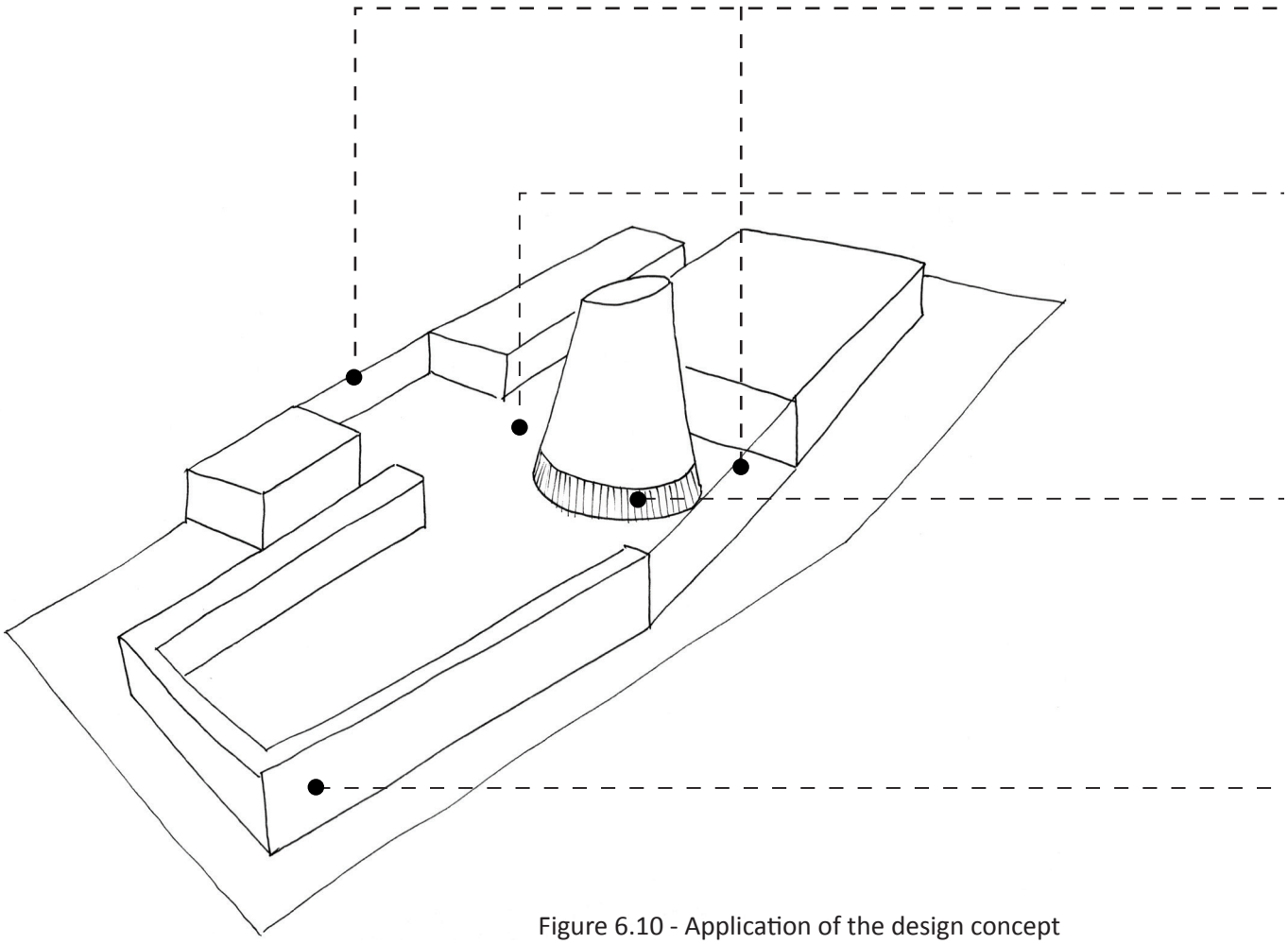
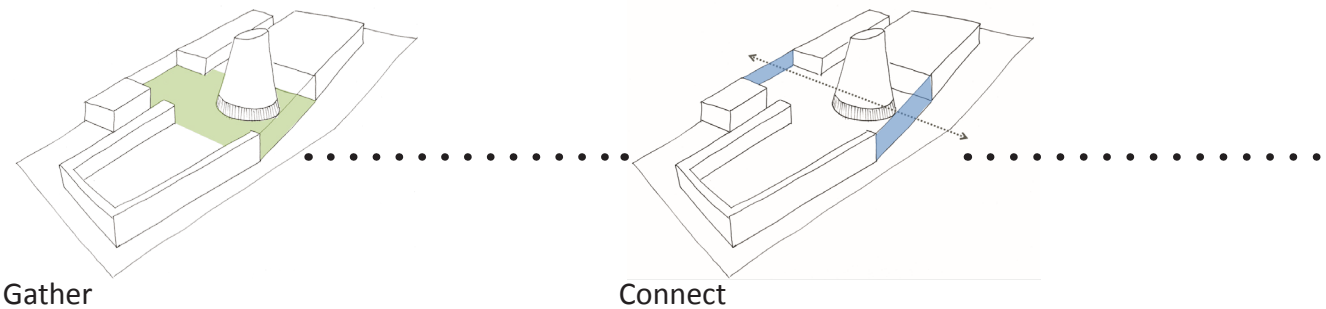


Figure 6.10 - Application of the design concept

The Building Design

The building design will create a space for the Waste Reclaimers and the general public to gather, connect, engage and reveal the process of glass recycling:



Gather

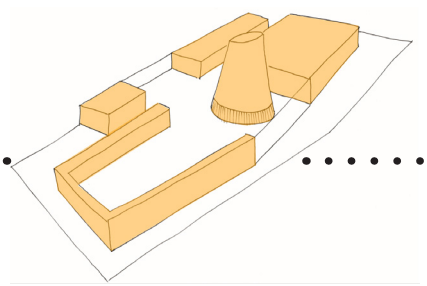
Connect

Opening the building up to the street edge allowing people to view the activities within the building.

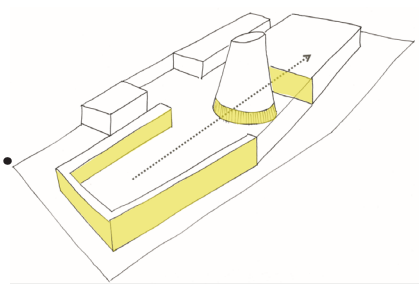
Circulation connecting activities of process and function

Lifting up the sides of the glassblowing hearth allows the entire glass recycling process to be revealed from the exhibition space through the hearth and into the factory space.

Glass Exhibition creating awareness and interest to the passing public



Engage



Reveal

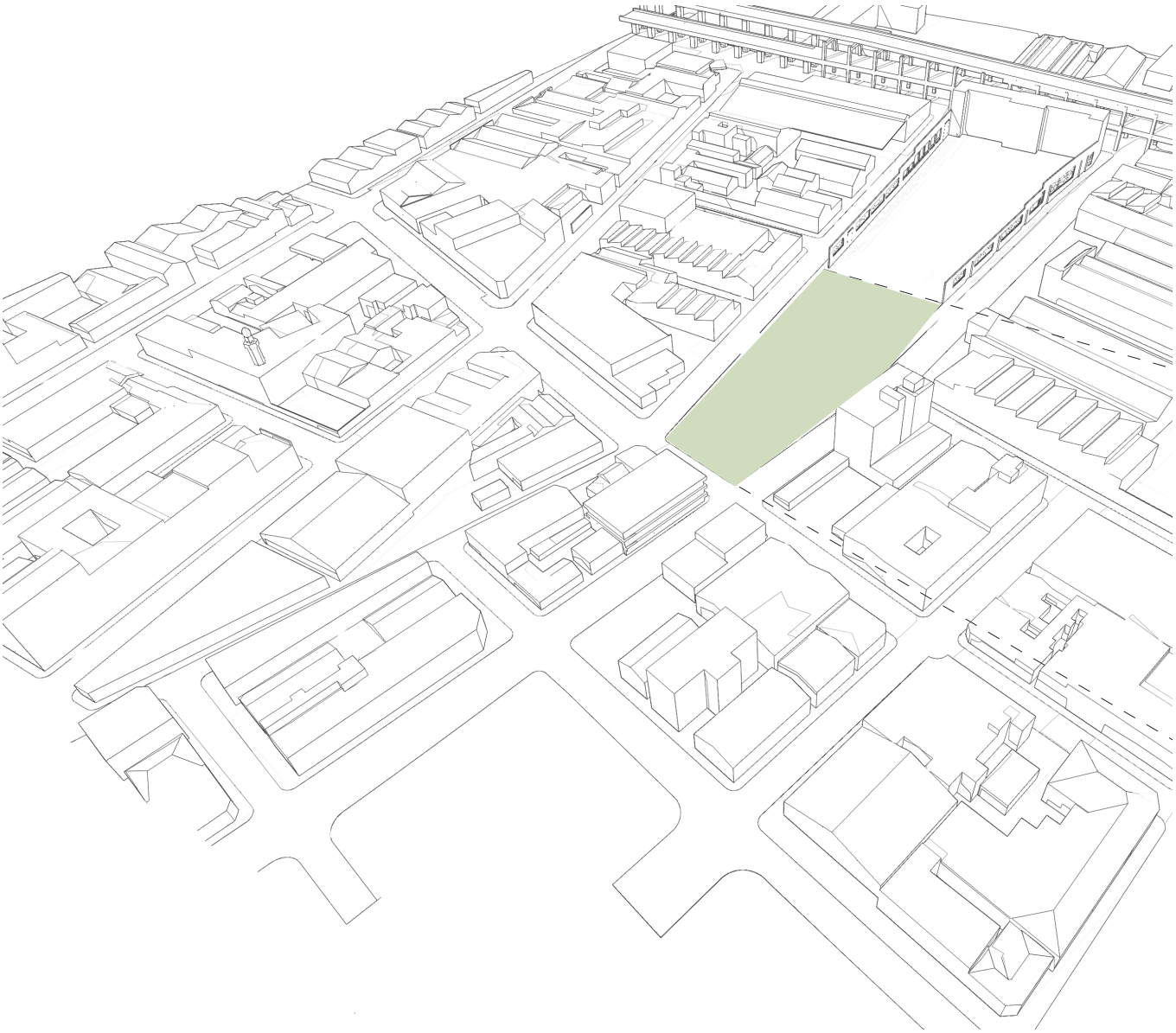
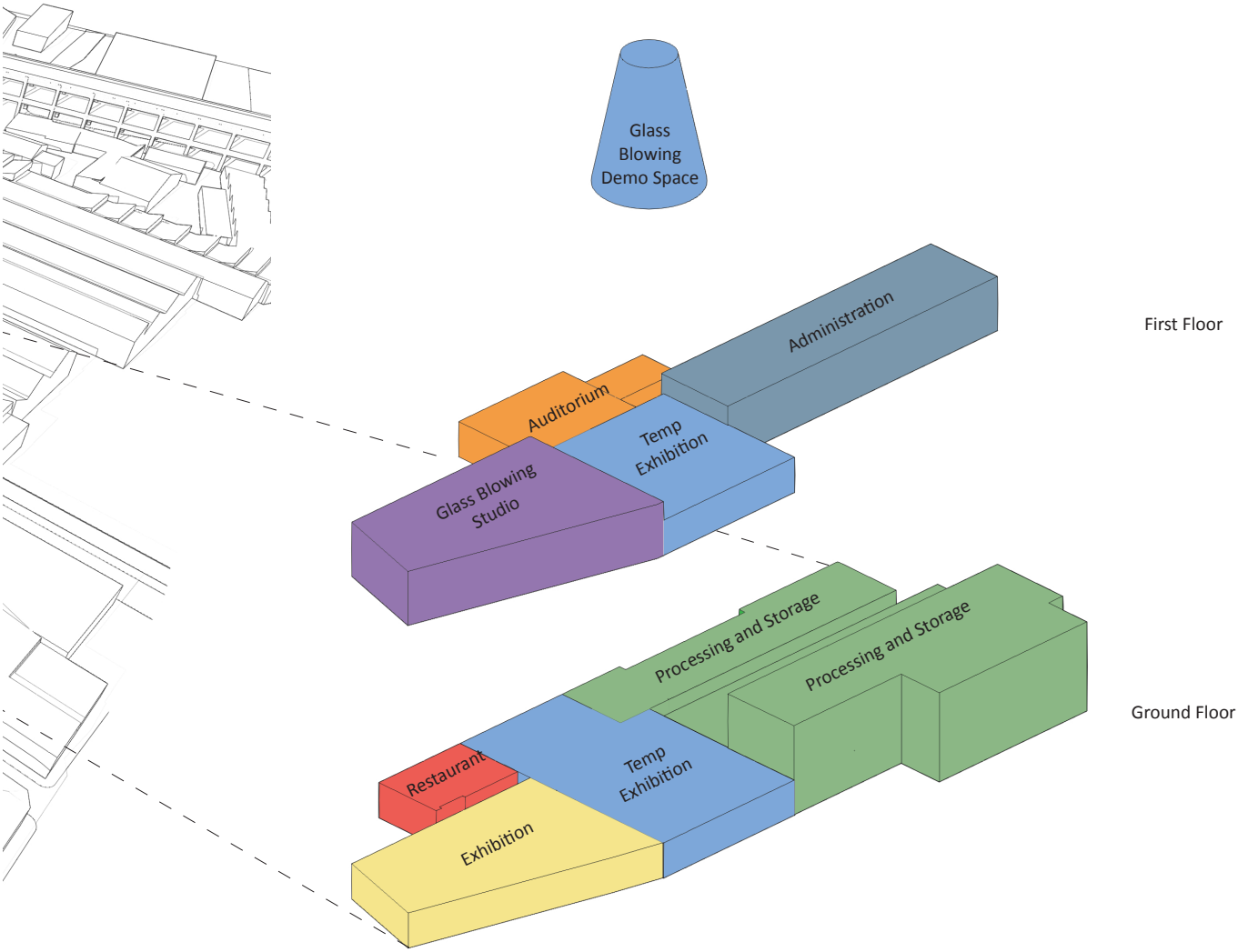


Figure 6.9 - Accommodation diagram

Accommodation Diagram



Sun Study Diagram

This diagram is a graphical representation of how the sun interacts with the proposed site during the course of the day. It also displays how this changes through the different seasons namely, summer, autumn, winter and spring. The diagram depicts the outline of the site and the angle on floor plan that the suns rays hit the site. The suns altitude during the time of day is depected above the site outline. The diagram simplifies the suns pattern of movement around the site providing a valuable design tool to ensure that full advantage is taken to capture and use this natural source of light within the building design.

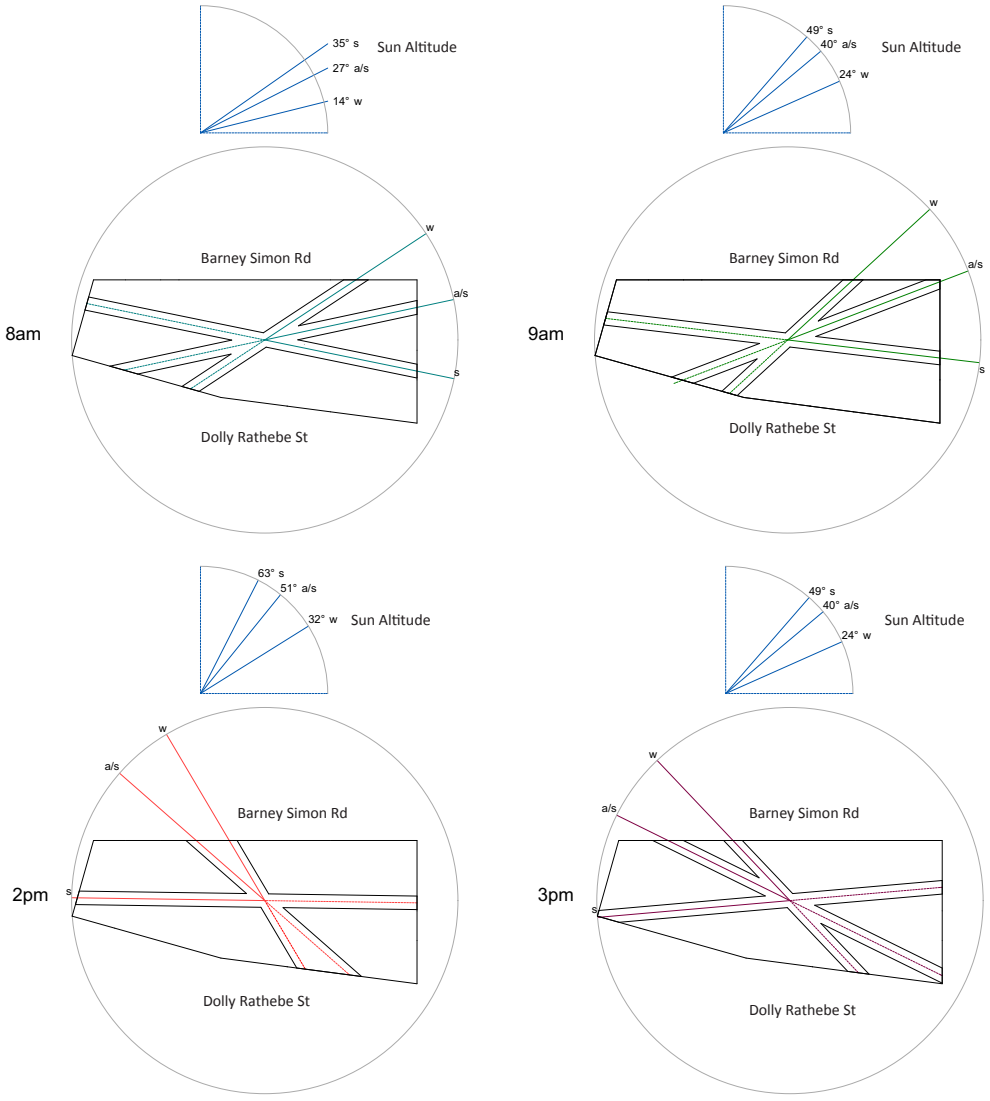
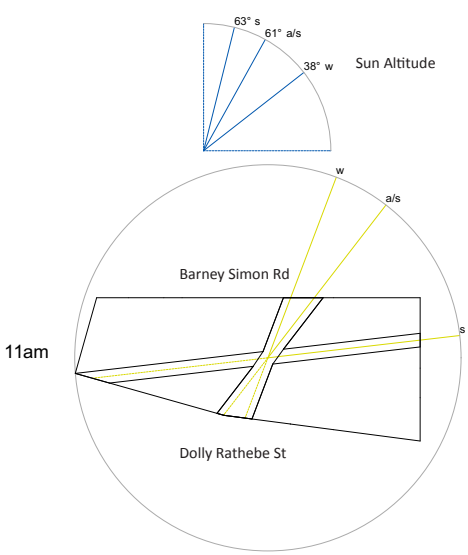
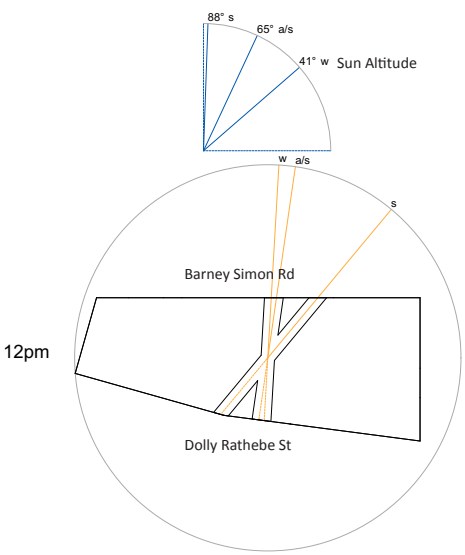


Figure 6.11 - Sun Study Diagrams of the proposed Site

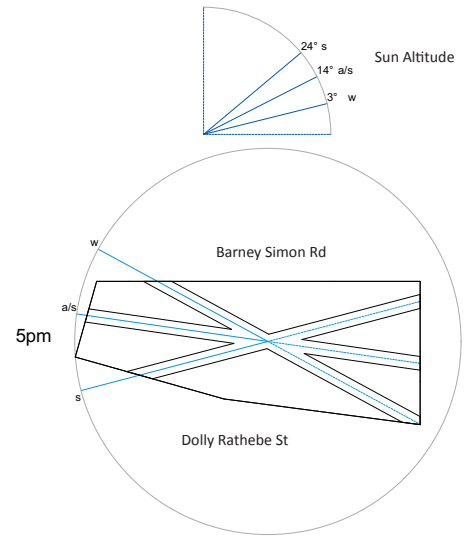
Key
The direction of the sun is from the outside of the circle towards the center of the site
w = winter
a/s = autumn/spring
s = summer



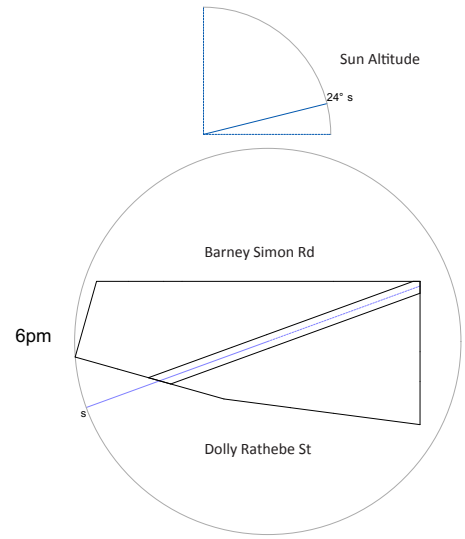
11am



12pm



5pm



6pm

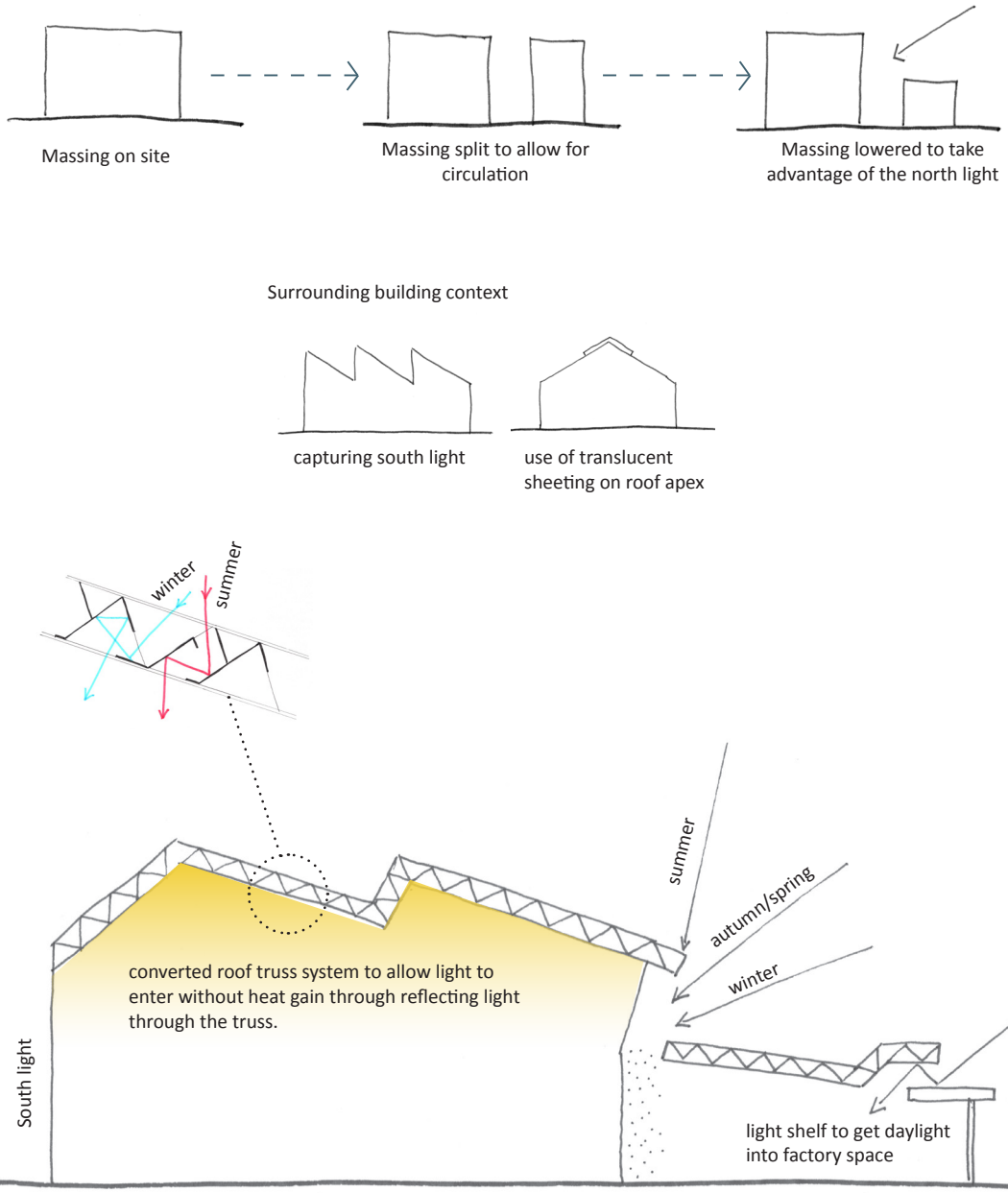
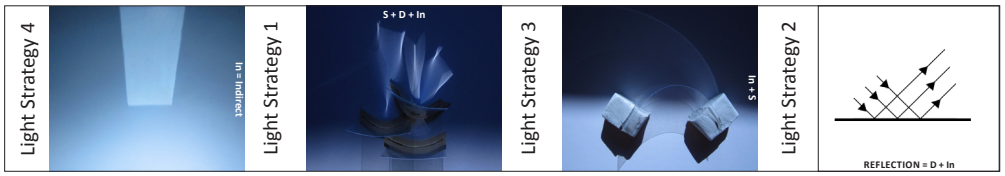


Figure 6.12 - Working with the sun to sculpt the built form

*Refer to Chapter 4



This light creates an atmosphere for learning and creativity.

creating a hearth a space of learning and exchanging of ideas

This light emphasizes a space of fluidity and movement

This light emphasizes a space of pause

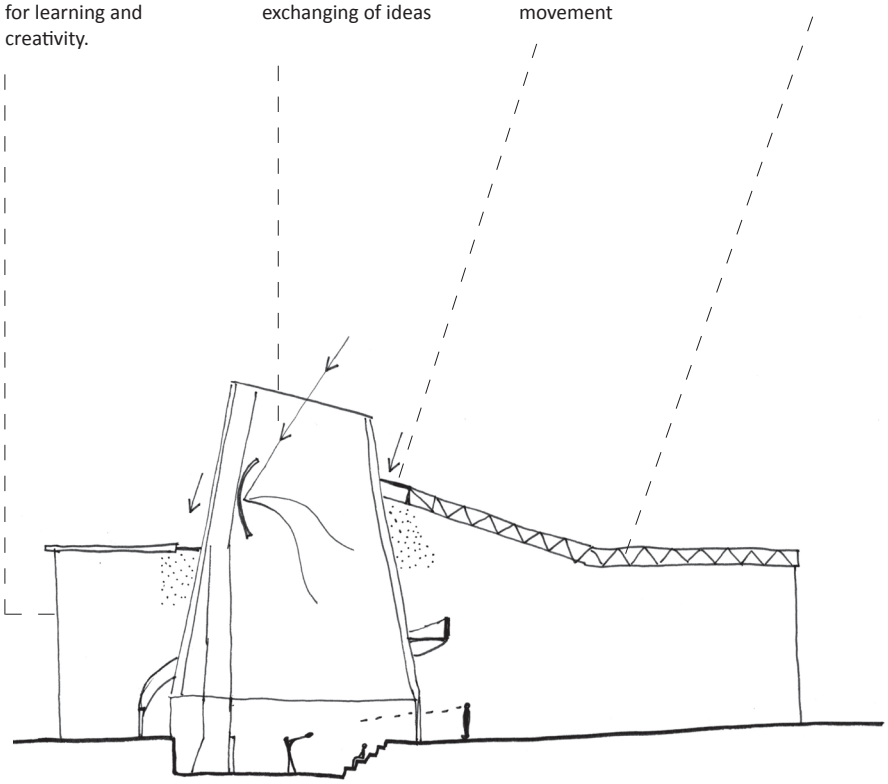


Figure 6.13 - Applying light strategies to enhance the experience within the building

Public Circulation within the building

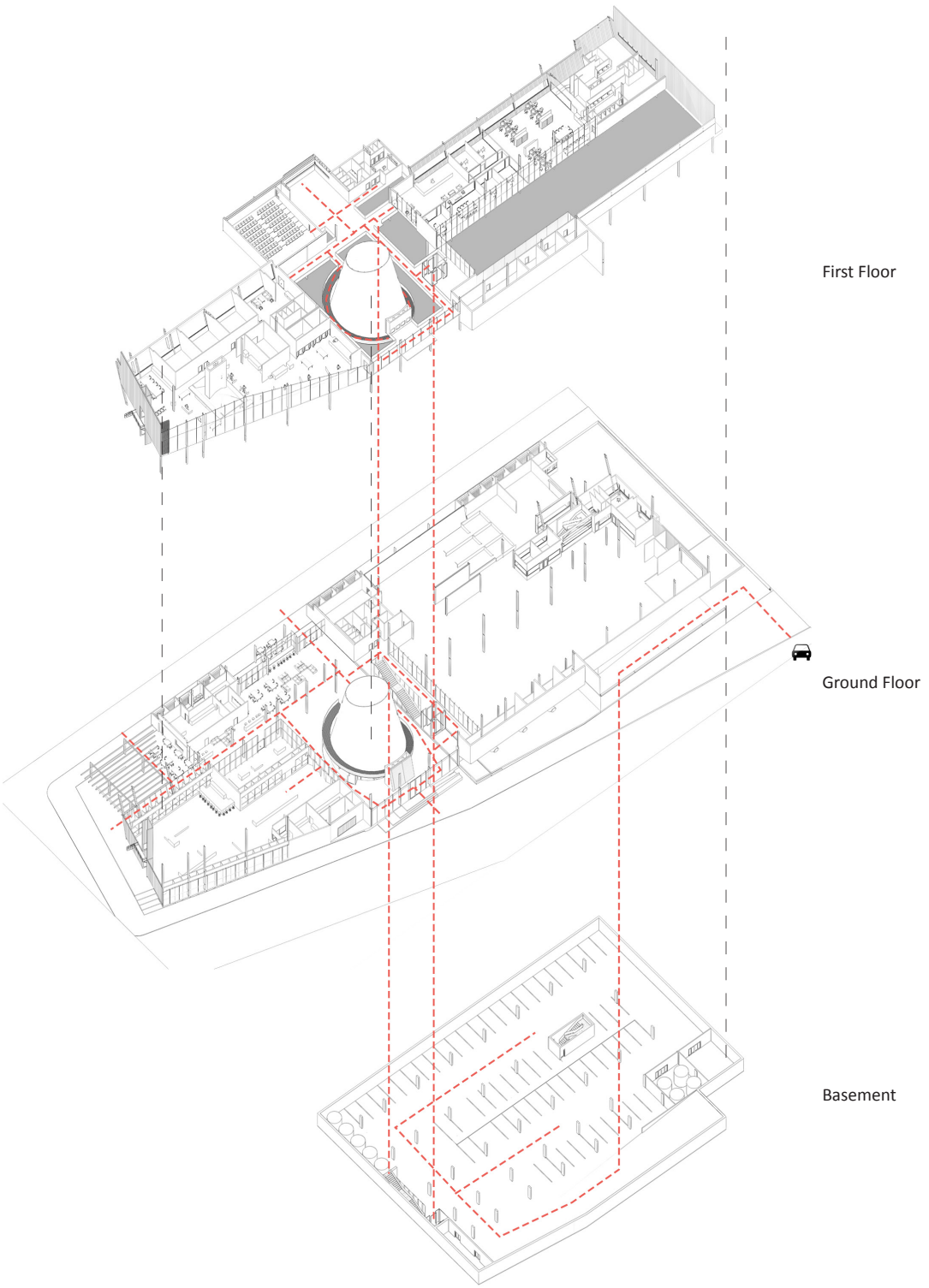


Figure 6.14 - Public Circulation Diagram

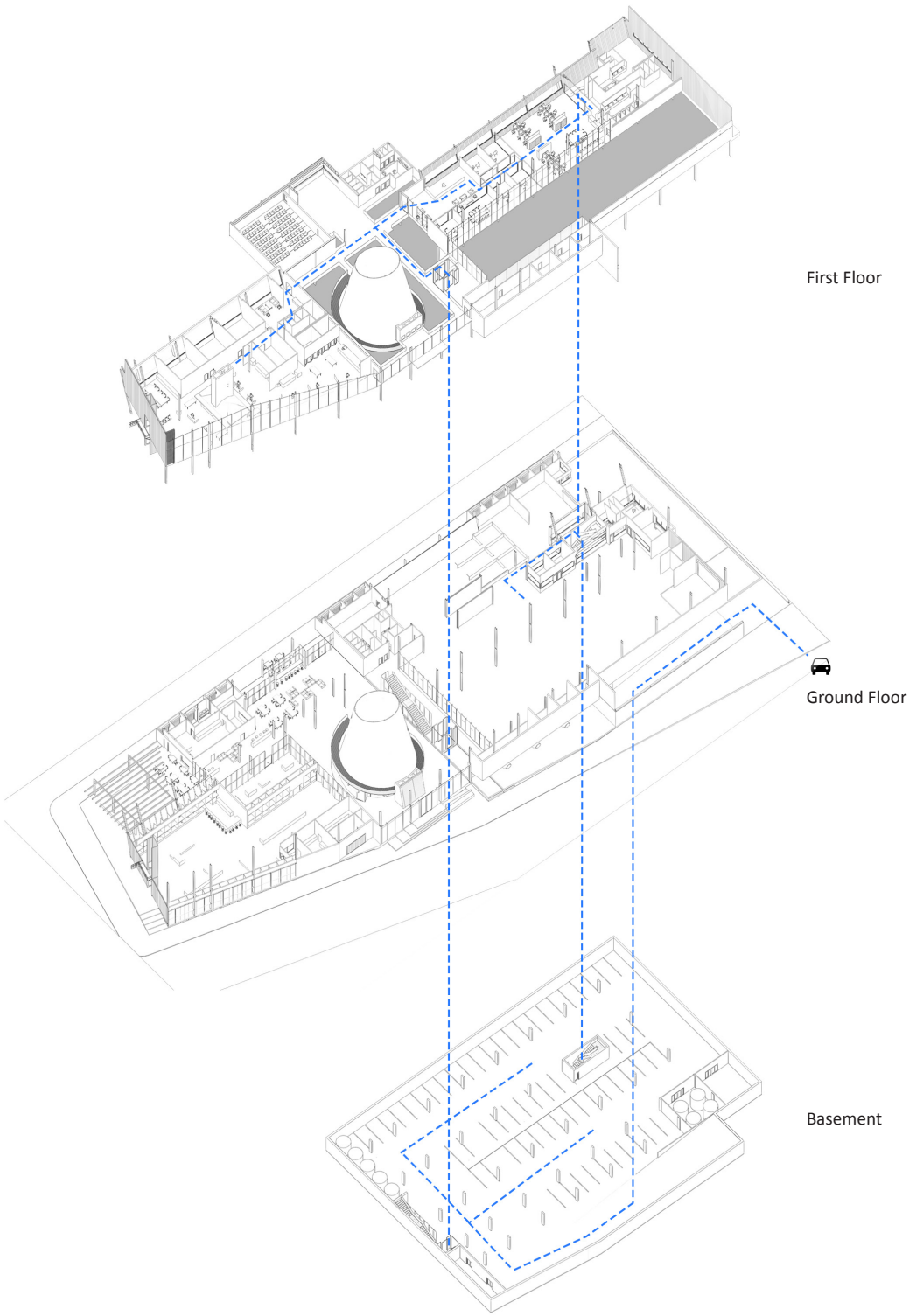


Figure 6.15 - Private Circulation Diagram

Glass Circulation through the factory

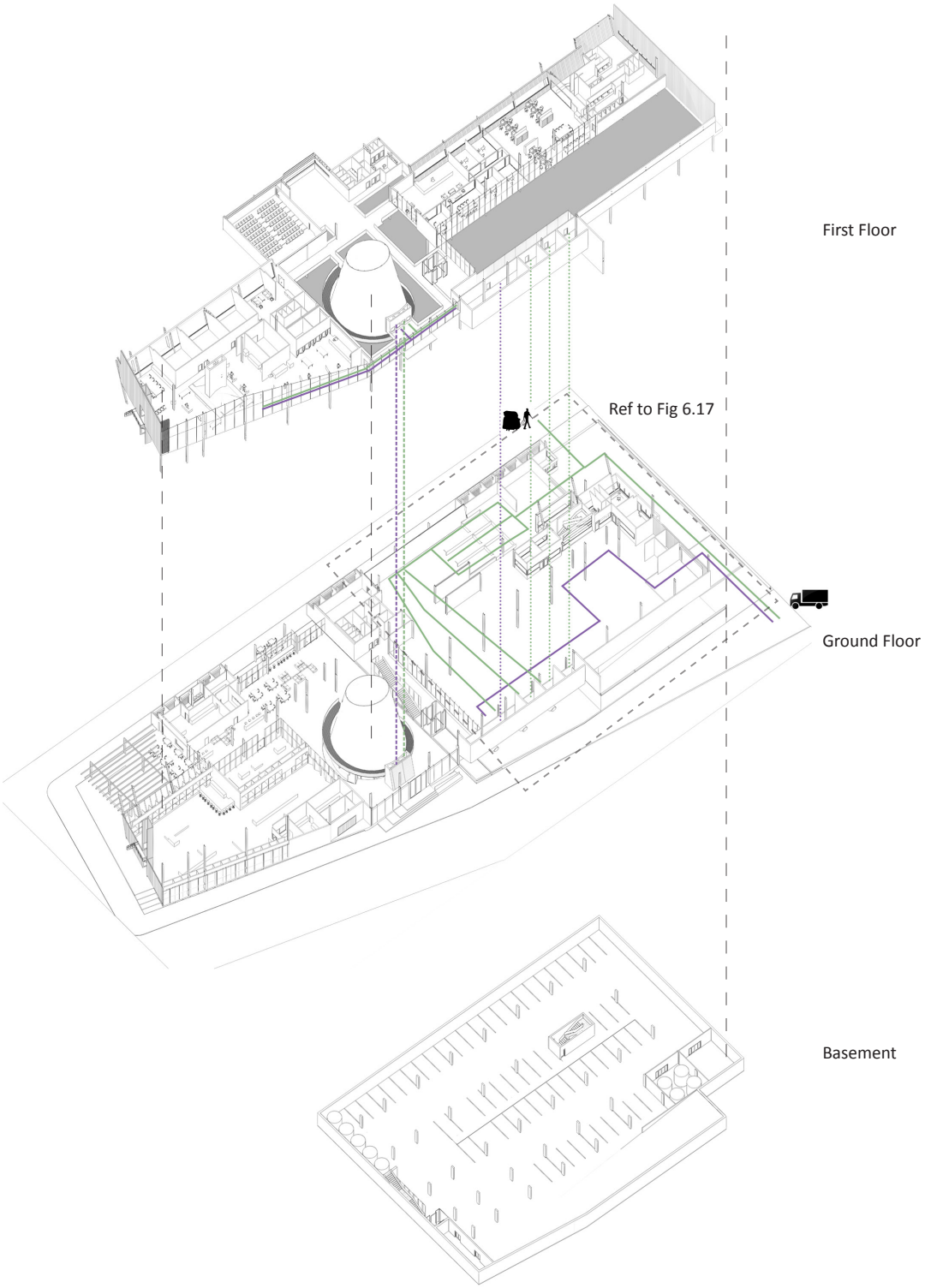


Figure 6.16 - Glass Circulation Diagram

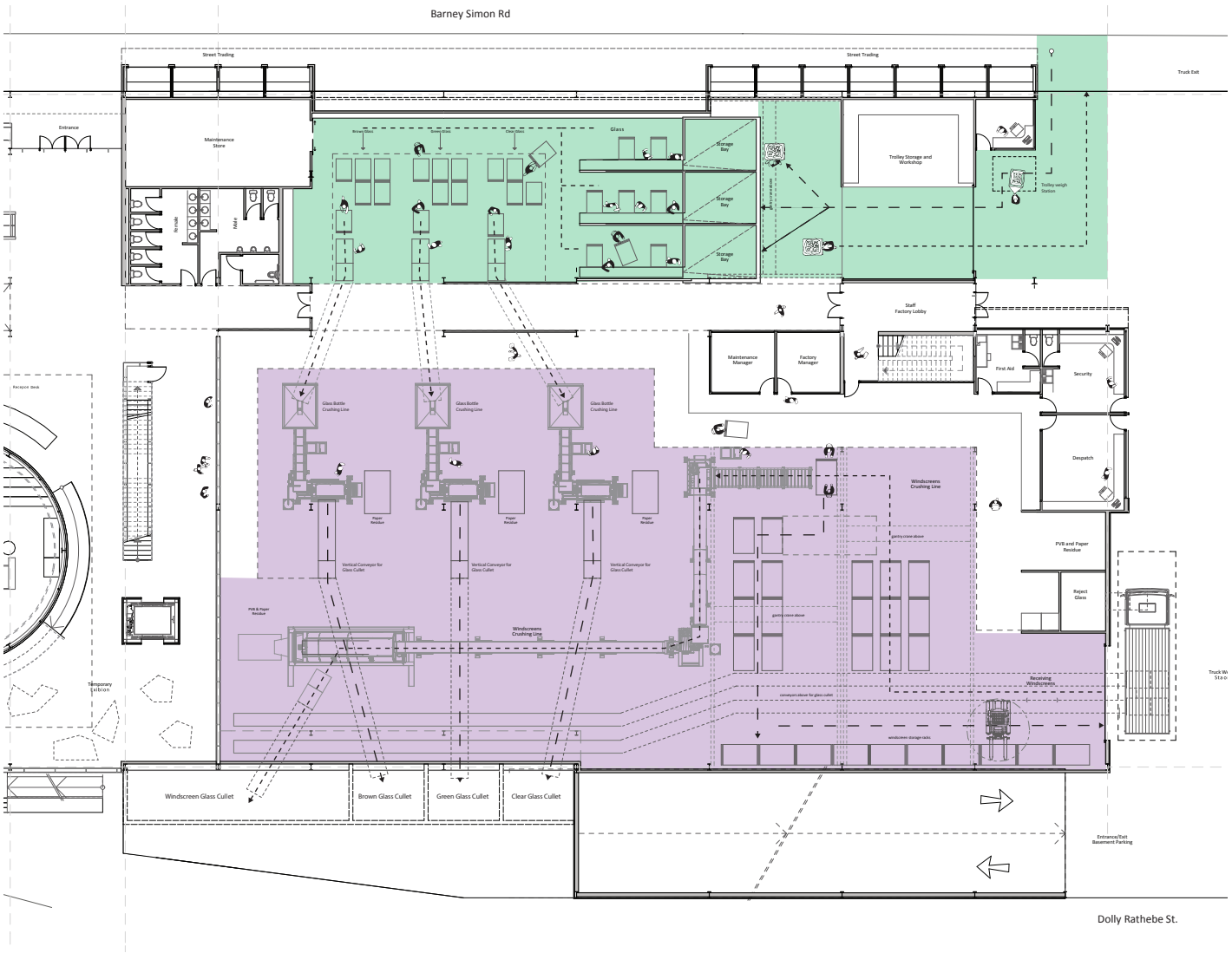


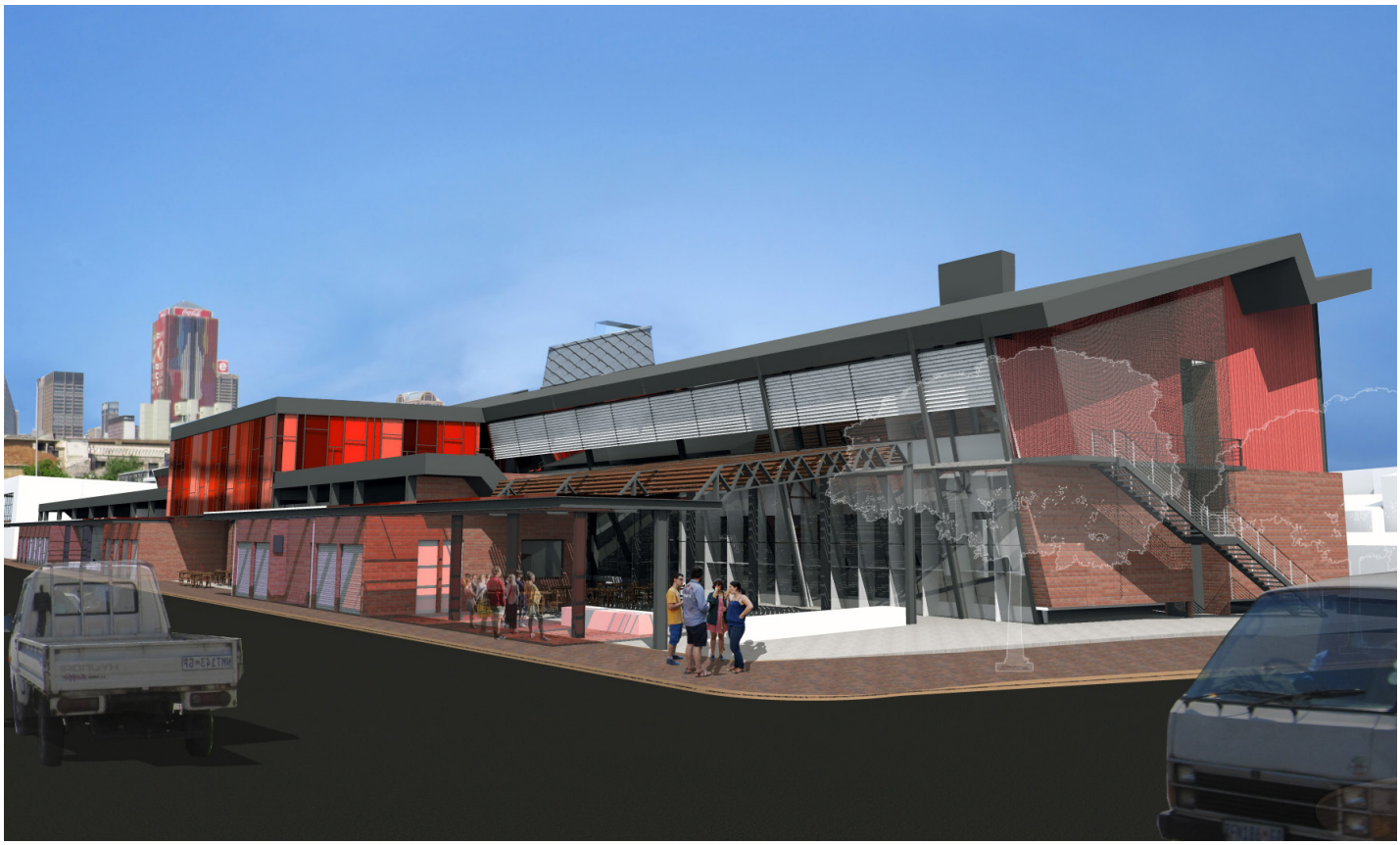
Fig 6.17 Activity Mapping of factory floor and flow of glass waste

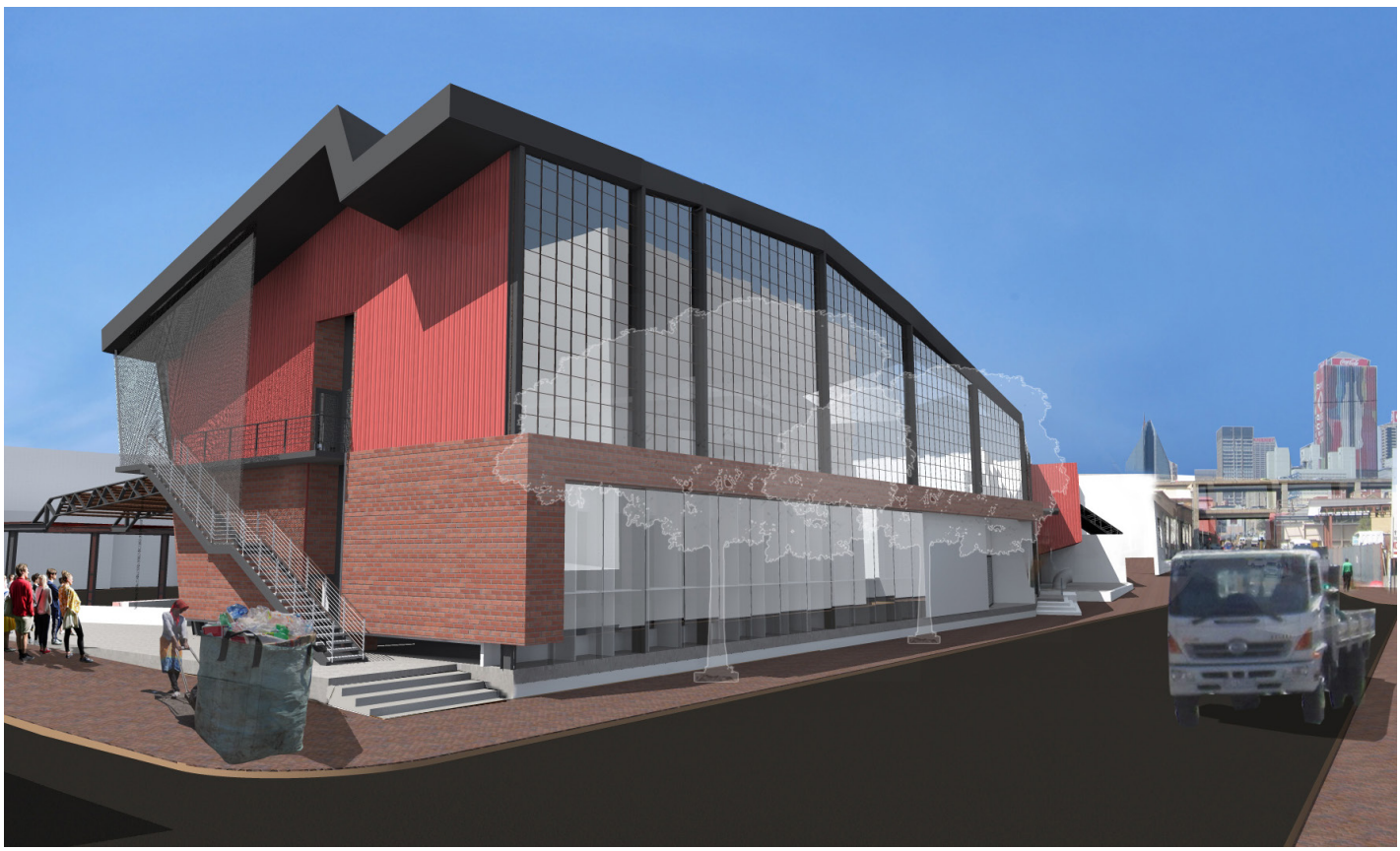
Glass Bottles/ containers

Glass Windscreens

*based on a capacity of 18tons of glass/day (9tons collected by 60 waste reclaimers the remaining will be windscreens received by vehicles)

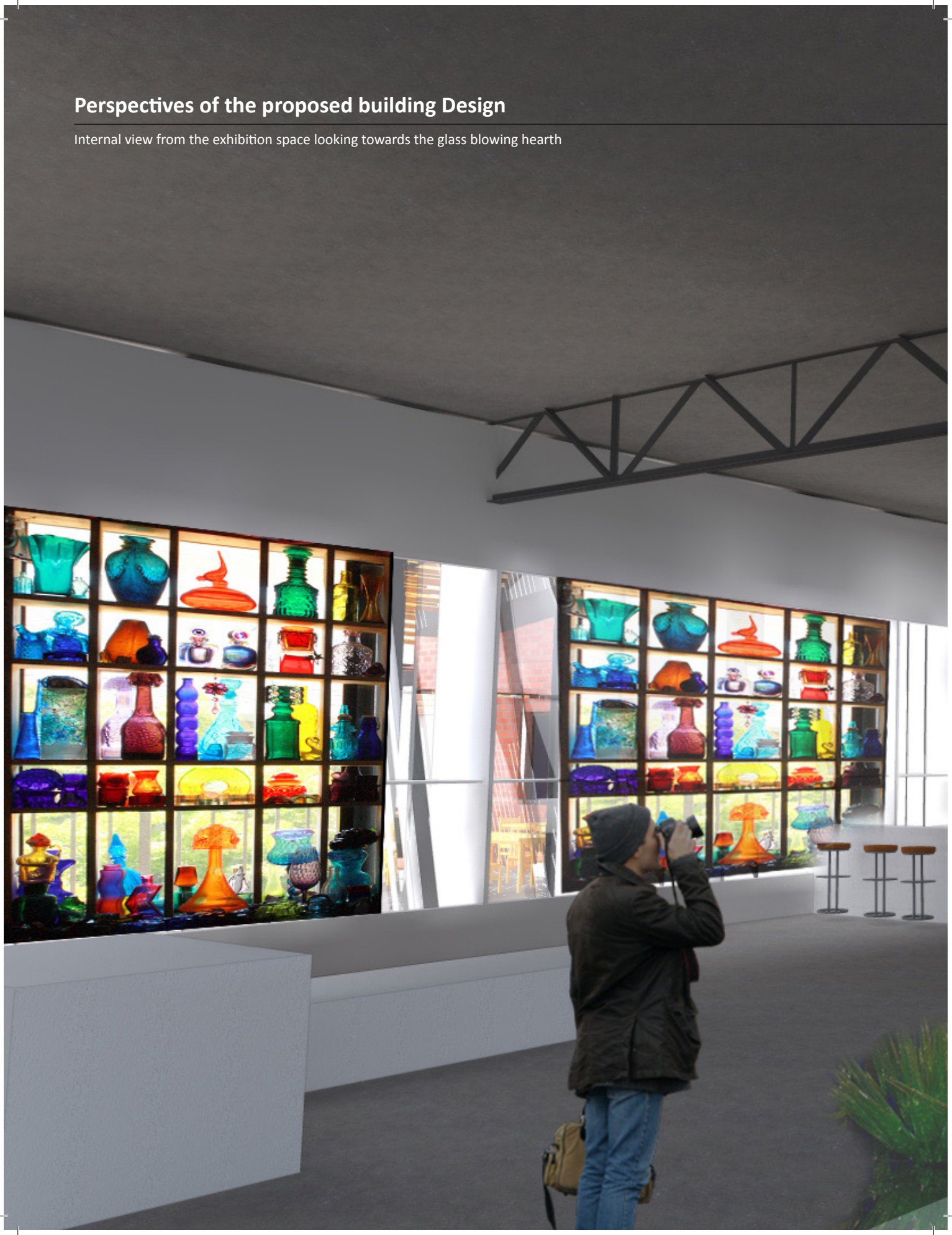
Perspectives of the proposed building Design - Street Level

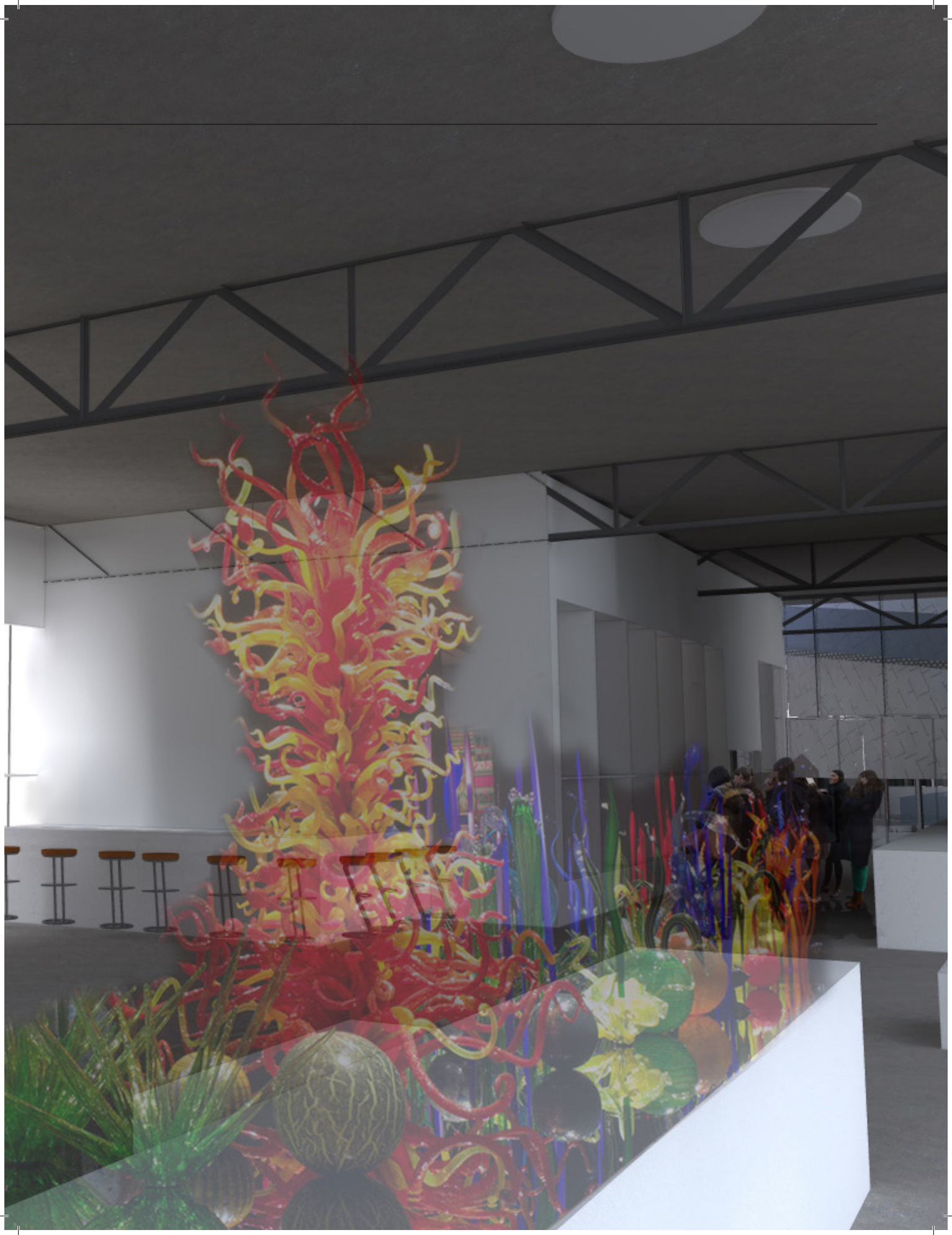


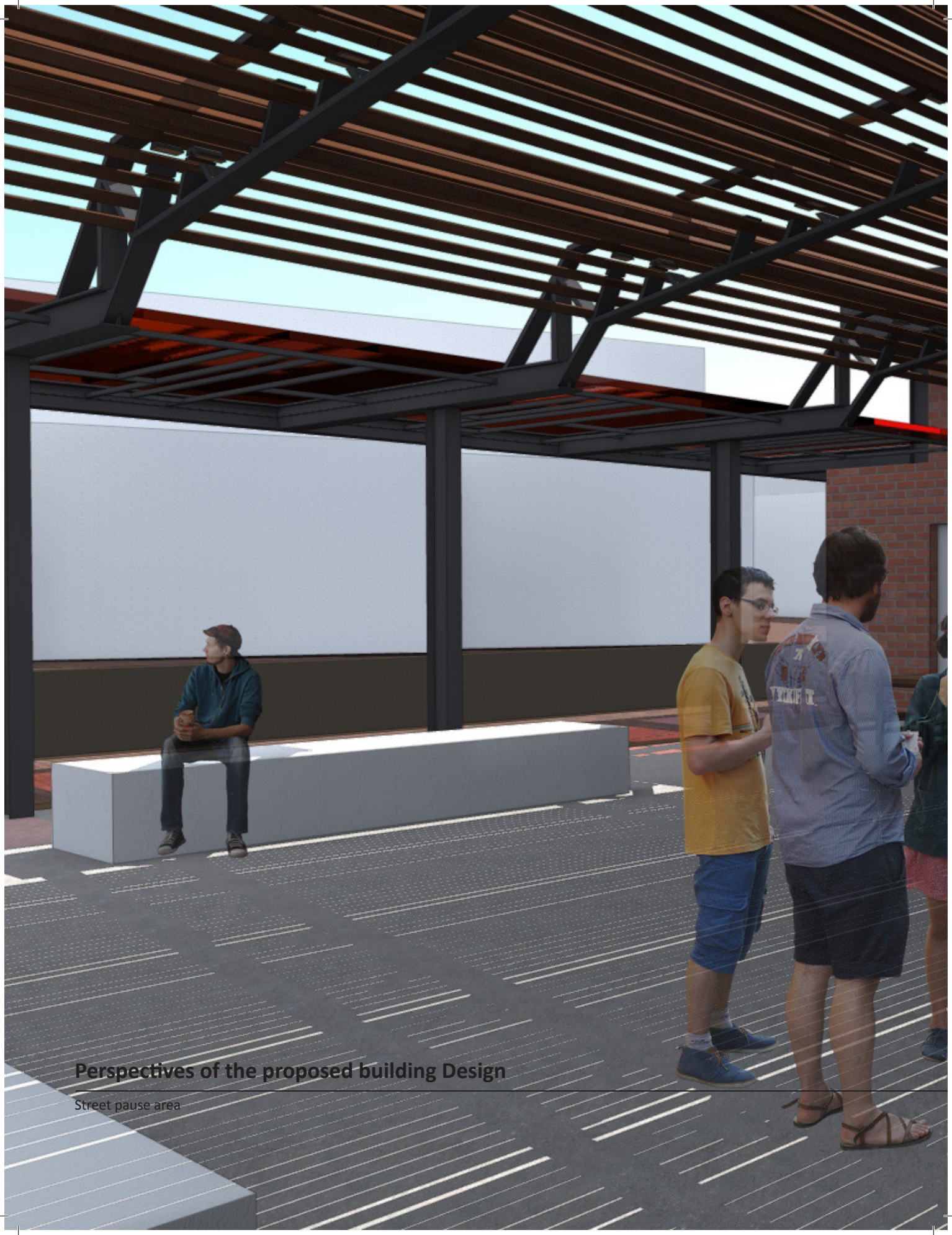


Perspectives of the proposed building Design

Internal view from the exhibition space looking towards the glass blowing hearth





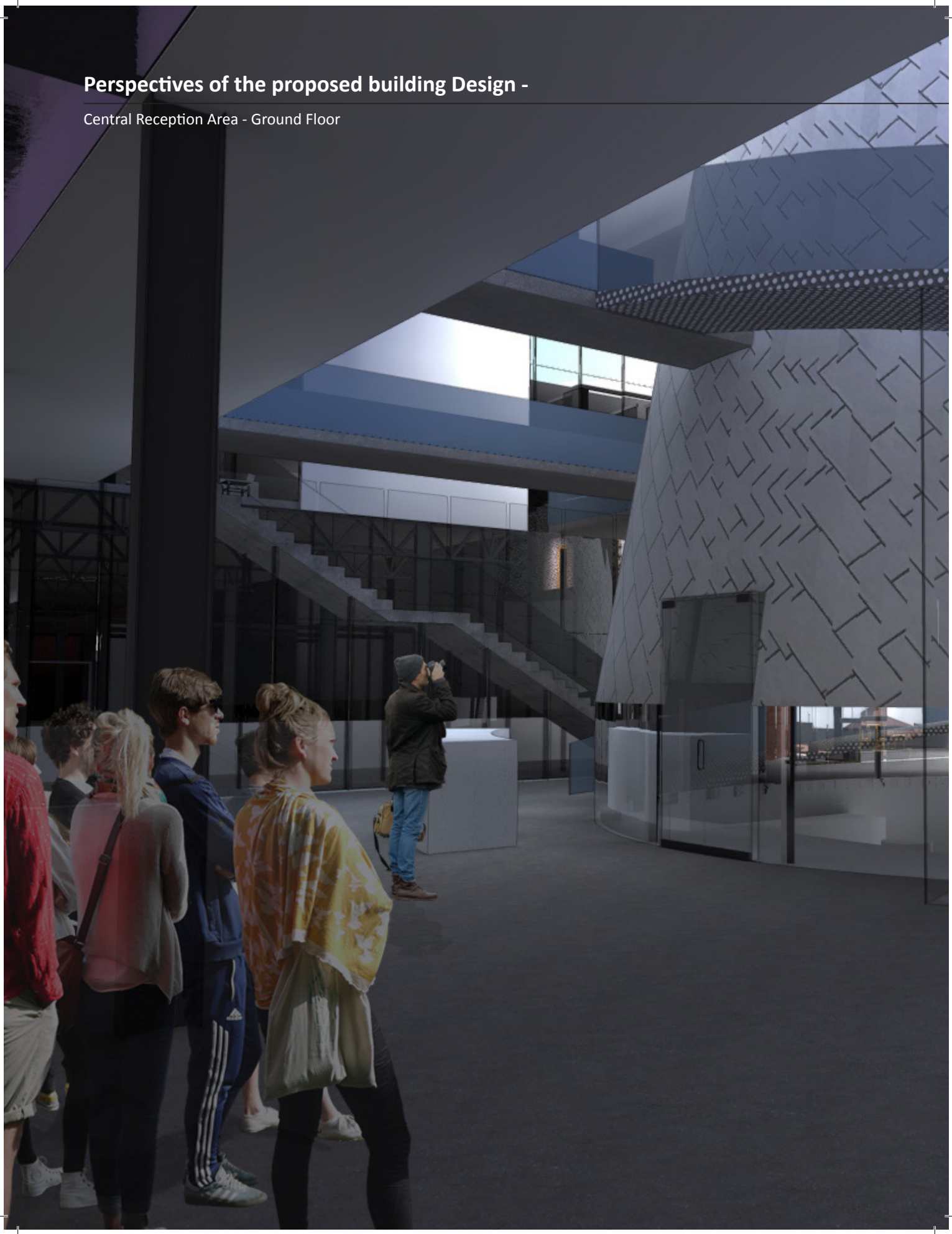


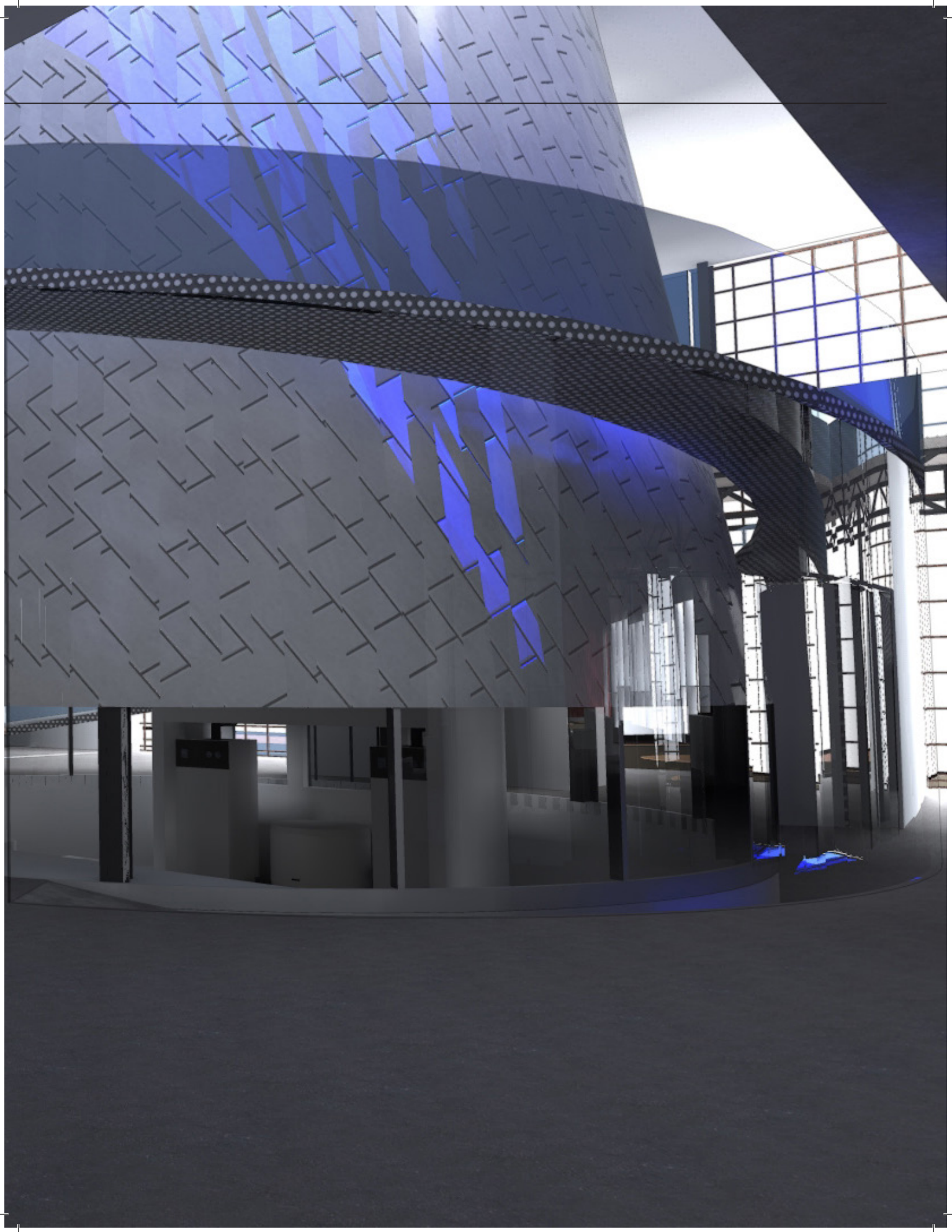
Perspectives of the proposed building Design

Street pause area

Perspectives of the proposed building Design -

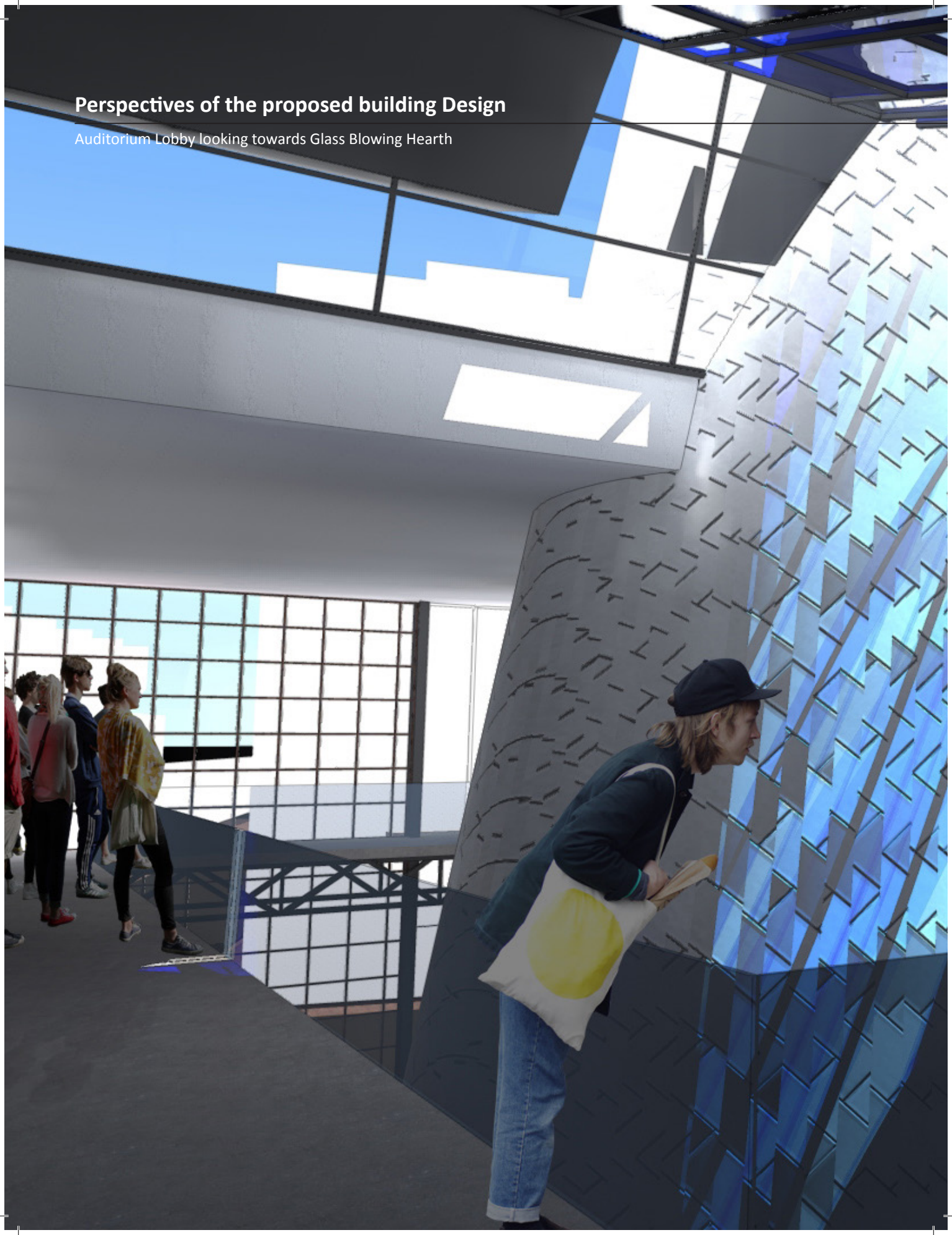
Central Reception Area - Ground Floor

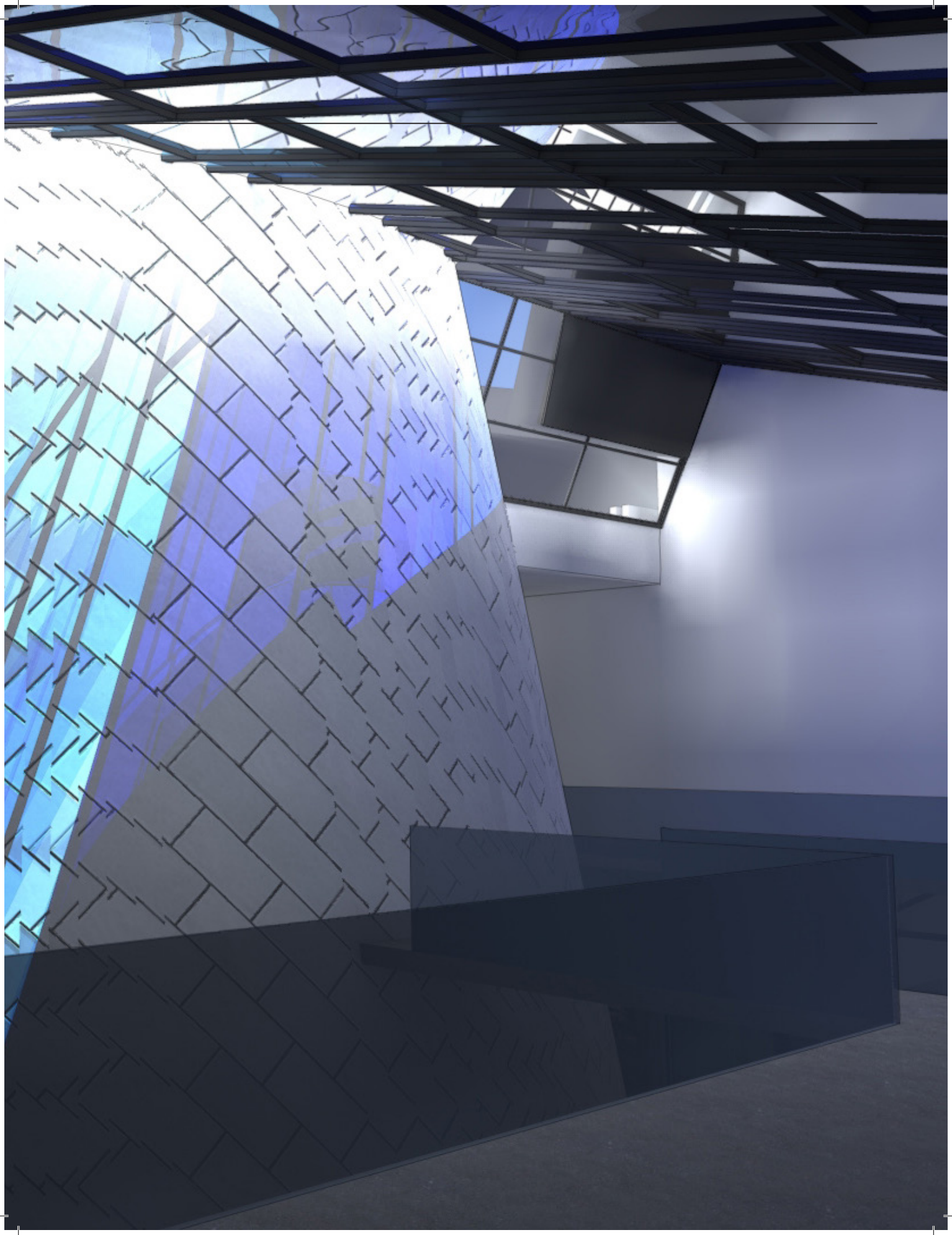




Perspectives of the proposed building Design

Auditorium Lobby looking towards Glass Blowing Hearth





Perspectives of the proposed building Design -

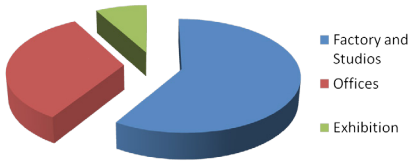
Central circulation along glass recycling process

System Cycles within the building: Rainwater Harvesting and Greywater Treatment

The water consumption calculation is based on a projected average water usage in the ablution facilities within the building.[(a)] This comprises of the changerooms for the factory, the public toilets for the exhibition section of the building and the toilets for the offices.

Rainwater Harvesting Potential
- Roof Coverage = 4300m²
- Ave rainfall Johannesburg = 52mm/month (BIKA,2014)

Total Rainwater Collection
= 3 161790 litres/year (JoJo, 2014)



Projected Water consumption
Total of 353600 litres/month[(a)]

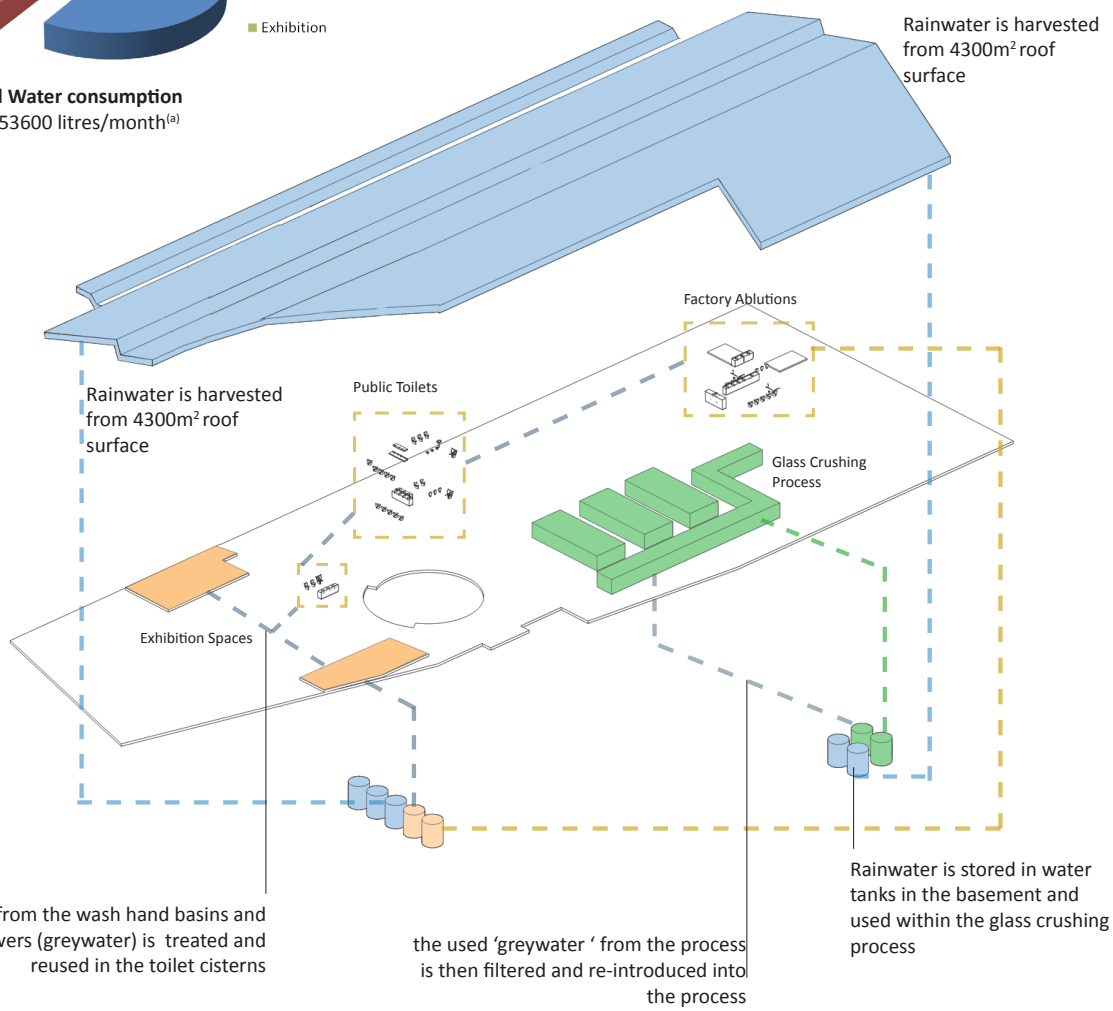


Figure 6.18 - Rainwater Harvesting and Greywater treatment Diagram

(a) The South African National Standard (SABS) basic water consumption rate:
- Factory Ablutions = 100 litres/ worker (80)
- Office with canteen = 10 litres/per 10m²
- Common space = 10 litres/person

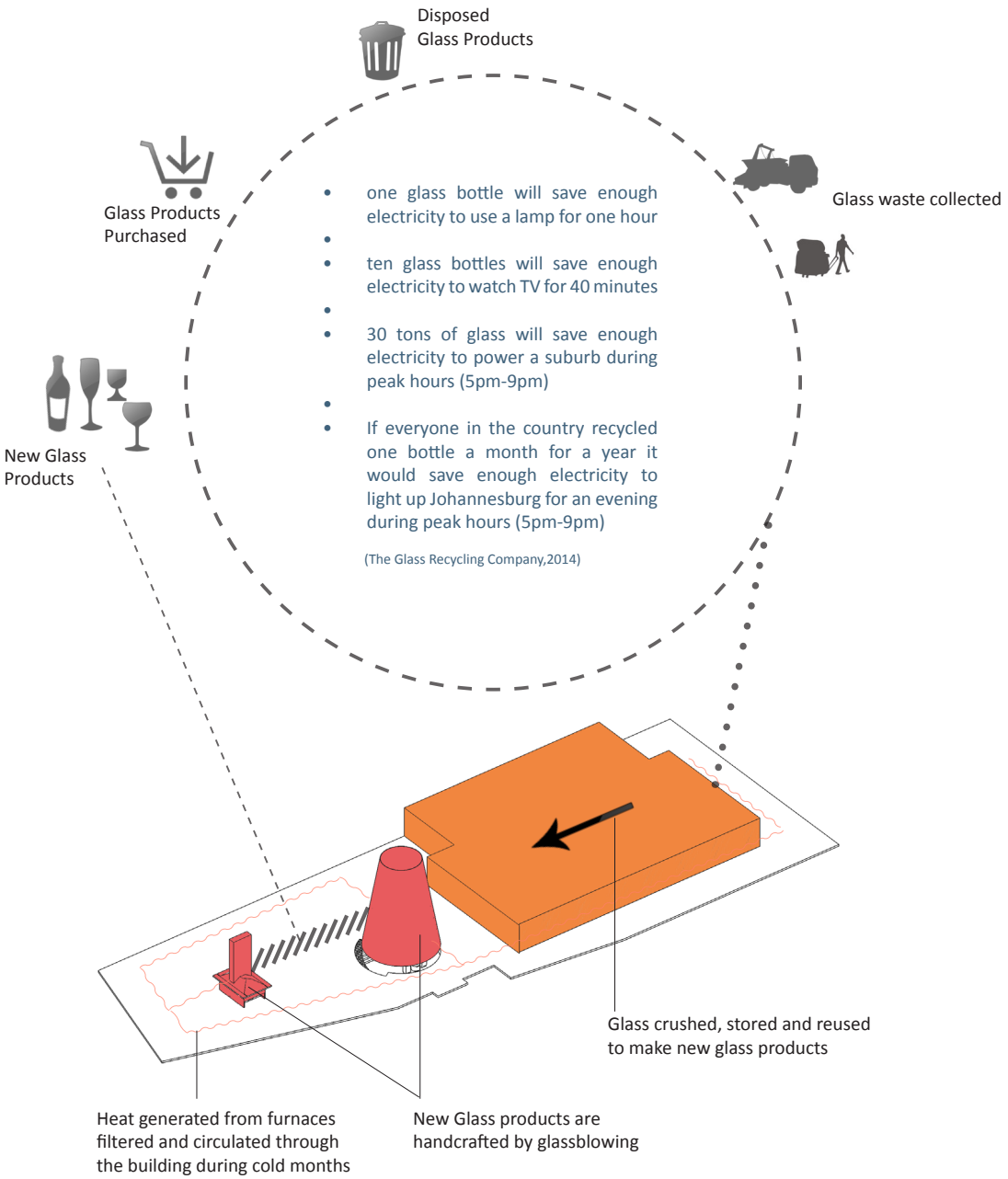


Figure 6.19 - Energy and heat Diagram

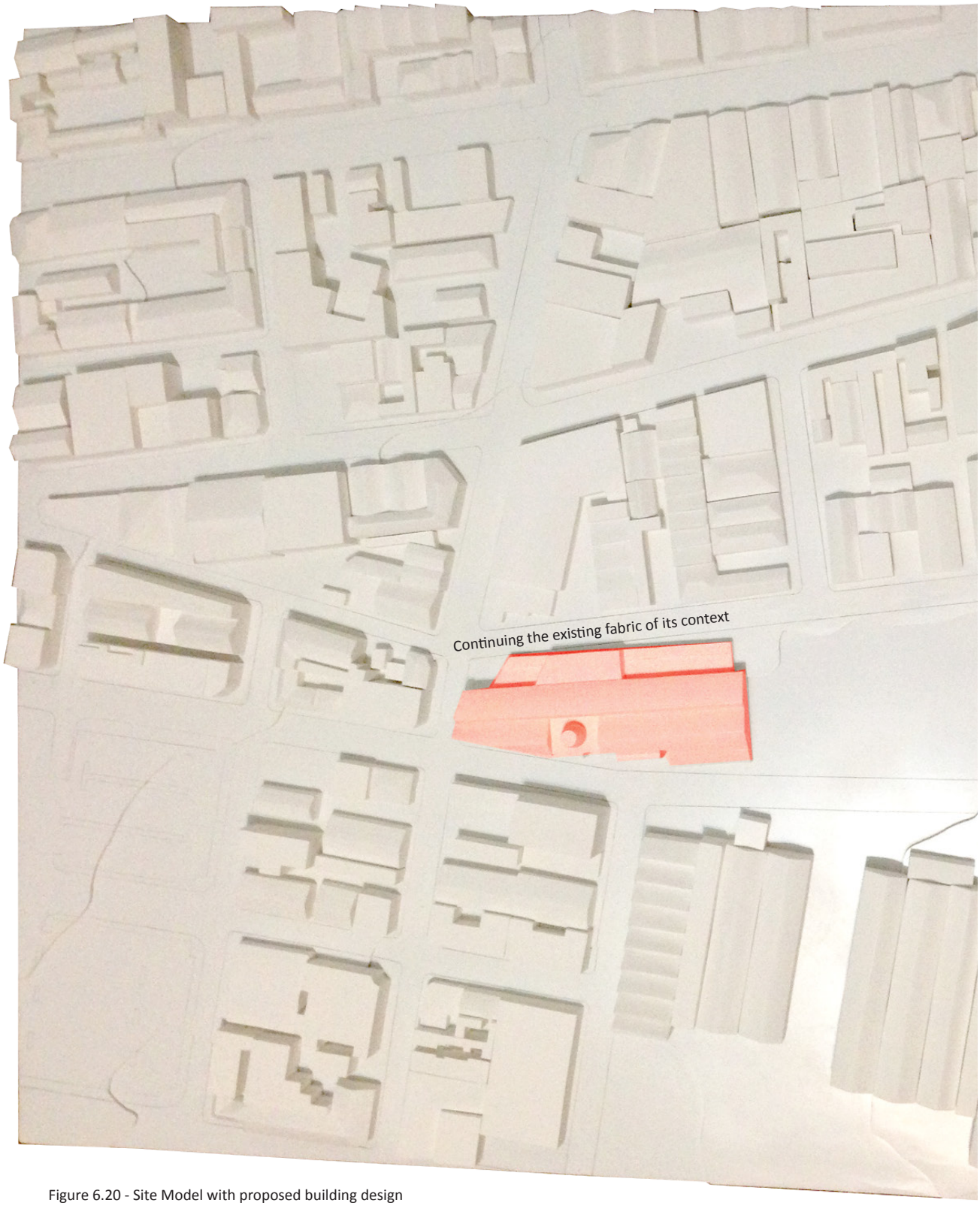


Figure 6.20 - Site Model with proposed building design

07 |

TECHNICAL RESOLUTION

The poetics of the detail

> "The essence of architecture is the poetic manifestation of structure implied in the Greek poesis: an act of making and revealing that is the tectonic. The structural unit is the irreducible essence of architectural form" (Frampton 1990:516).

The oxford dictionary defines "tectonic" as that relating to building or construction. However philosophically tectonics can be understood as a network, a phenomenon of connection, links and bonds between separate elements (Koch 2012:174.) "Emphasis occurs at the bonds or the relationship between different objects, rather than objects themselves. These tectonic expressions are evident in a congestion of spaces, functions, programmes, voids, structures, access routes, public and private domains" Van Toorn (1993) as cited by (Koch 2012:174).

"The Primative Hut" by Marc -Antoine Laugier's published in his Essay on Architecture in 1755 can be regarded as a 'natural' architectural form, embodying a universal relationship between form and necessity. Laugier considered this to be the primitive building type from which all architecture originated (Hvanttum, 2004:31). The primitive hut can be interpreted as architecture in its true form and by meeting the simple conditions of the gathering of people and creating shelter from the elements. The hut comprised of three basic elements of architecture; the post, the lintel and the gabled roof (Hvanttum, 2004:31). This however is a mythical interpretation evident in the illustration by Charels Eisen (Figure 7.1) Gottfried Sempers on the other hand rejected this typological basis and generic function in his book "The Four elements of architecture" in 1851 reprinted in 2011. He proposed that one type of building cannot be the origin of all architecture. He believed that architectural form varied according to how different human societies developed and how climate, natural surroundings, and social relations influenced them Semper (2011:103). Sempers proposed four tectonically based elements namely earthwork (mound), hearth, roof (framework), and enclosing membrane (Frampton,1990). These elements were interpreted from a vernacular Caribbean hut. (Figure 7.2) Instead of a frame construction in a single material, "Semper offers a grounded, heavy foundation condition, with a light frame and infill above and the essential connections between the two" (Frampton 1990:517). Semper (2011:103) explains that the combinations of how these four elements of architecture were arranged varied according to it context. Semper further refers to the knot as being essentially the first joint that connects these elements to create the shelter.

"The structural unit is the irreducible essence of architectural form" (Frampton, 1990:50). Therefore the structural unit is irreducible because you cannot reduce that structural unit to a gable, you reduce it to its connection. Laugier's elements of post, lintel and gable roof are not reductions these are generic functional elements. The elements proposed by Semper may seem to be basic however, his position is that you cannot just look at hearth as a generic thing or element, you need to look at the detail of the hearth to understand it just as much as you have to examine the detail of the roof and the connections.

The poetics is not in the generic elements like the post, lintel and gable but it is in the details, connections or the material. The nature of the details connections and the material implies a certain condition, which gives you the poetry.

It is from Sempers proposed four tectonically based elements namely earthwork (mound), hearth, roof (framework), and enclosing membrane that the technical resolution of this thesis is based. Examining the factory tectonic and relating it back to the four tectonically based elements, provides an approach to achieve a comprehensive technical resolution for this thesis.

Marc -Antoine Laugier

Figure: 7.1 “Allegory of Architecture Returning to its Natural Model.” Laugier (1755)

Gottfried Semper

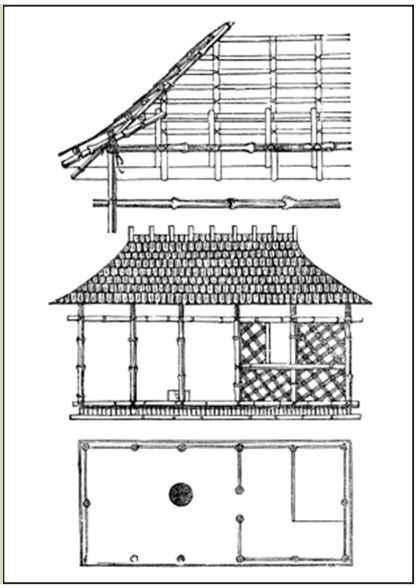


Figure 7.2: “The Caraib Hut”. Semper (1878:263)

Semper's four elements applied to Factory Tectonic

The following clarifies the meaning and purpose of the four elements associated with a generic factory building .

1. Hearth
This represents the generic "gathering" of people. In a factory it is about the gathering of people and industrial process in a logical and systematic sequence within a large space.
The hearth in terms of the proposed design is distributed over a bigger area so it is the hearth that is laid out as an assembly line. It also represents the way people move through space in their various sequences from one space to another.

2. Mound (Earthworks)
This is the floor plan it provides the a platform in which activities are arranged to allow different activities to interconnect and relate accordingly. It is how the hearth (gathering) is laid out. It comprises of the horizontal Lifeworld where people interact on a practical level every day.

3. Membrane
This is the infill and cladding of the exterior of the building it generally comprises of cheap materials but sufficient to keep external elements out. Membrane represents the threshold between two different conditions. Within a factory this threshold will separate the specialized activities and zones of the production process. On a large scale it is the threshold between the exterior and internal environment of the building.

4. Roof (framework)
This is the steel structure and roof which comprises of steel members with the ability to span large distances. These building structures are associated with the following types of buildings; factories, aircraft hangers and warehousing. It represents shelter.

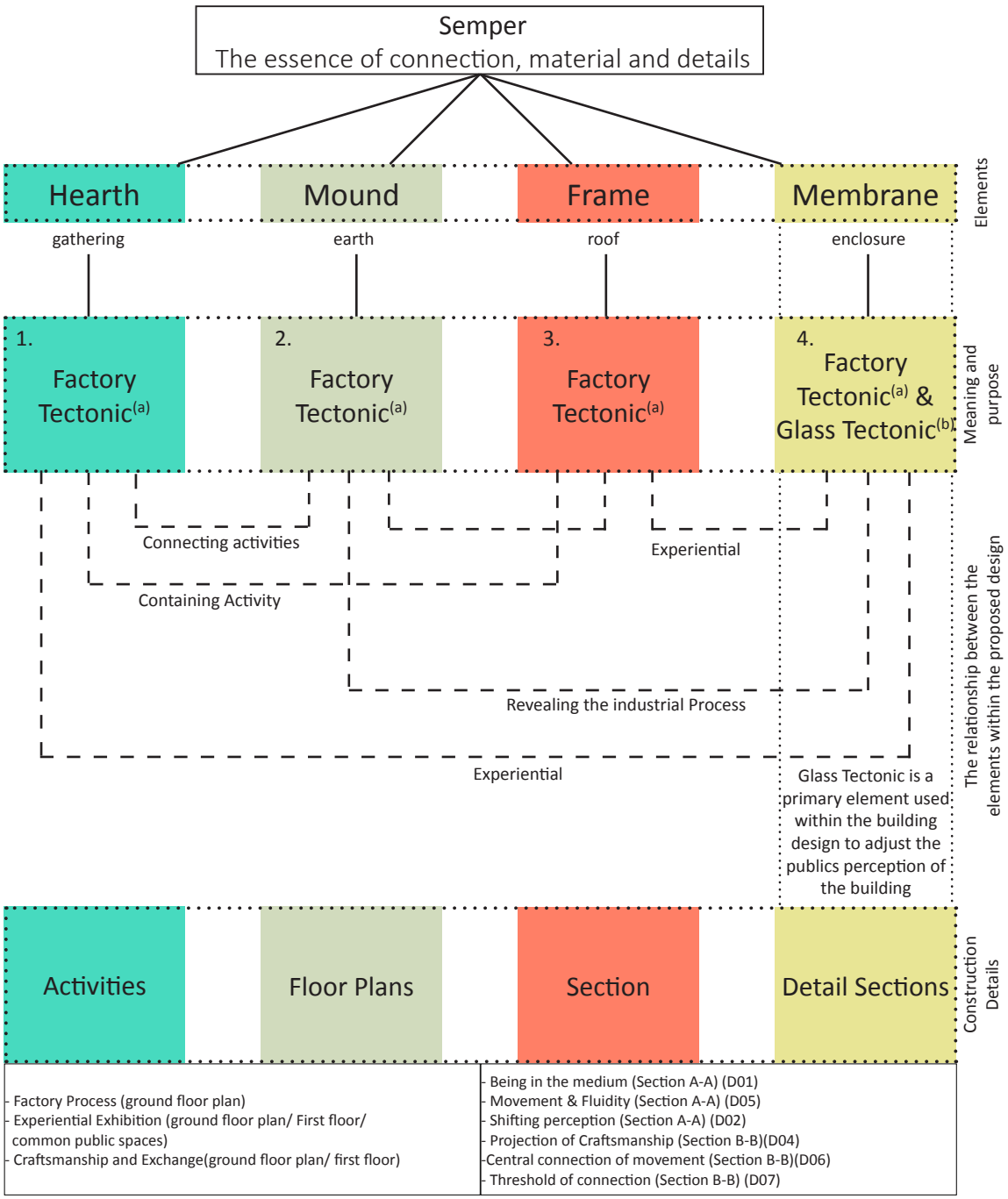
The relationship between the elements within the building design.

The proposed architecture is not just about gathering and the coming together of people and processes. On a large scale the meaning of The Glass Recycling Factory within the City of Johannesburg is to create a space where people can come together. It is a central location for all users. On a smaller scale the building itself becomes more tectonic referring to the large span structure and how both people and process are arranged within this space according to their different functions.

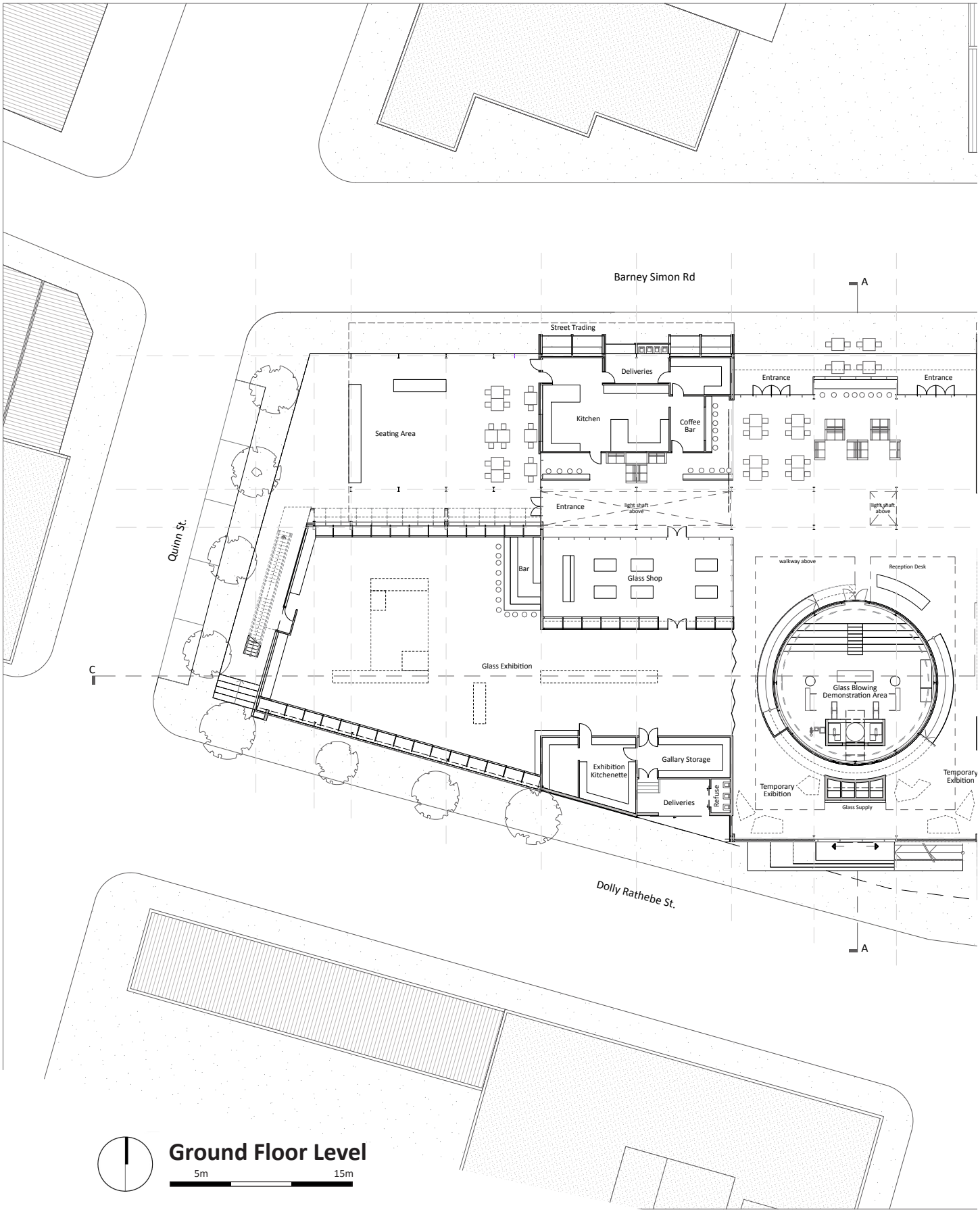
The central glass blowing demonstration area is a central focal point within the design and therefore a conscious decision to create a space within the building that gets back to the idea of the hearth in its most true sense by centrally gathering people and creating a place for learning and exchanging ideas. The remaining areas of the building are also about gathering but the gathering of people within a process space. Therefore it is about movement and the separation of different functions and how these connect and interact systematically and experientially

The membrane presents an opportunity to shift the perception of the public and create an interest and an awareness in the proposed design. It is through the application of glass in specific ways that this awareness will be created. Glass is not something you associate in factories the only glass you associate with, is the small pane glass windows. The application of large sheets of glass has been used in strategic places within the building to contrast associations with this factory type building. This will increase peoples awareness that this is not just a factory.
The nature of big panes of glass is associated with exhibition spaces and stain glass windows are associated with churches. Through the application of these different forms of glass it will therefore contribute to the experiential and exhibition aspect of the building. Therefore,

these applications of glass within the factory will emphasis the fact that the factory itself is on display. It also ensures that everything in the factory is on display highlighting that this space is not just functional but it is also being deliberate and self conscious to display the process. Glass by nature is exposing putting things on display but it is also experiential and it emphasizes the experiential aspect of the building. It therefore warrants that people will not just walk past the building and see it as a building, but it is becomes something that they can experience by being able to see through it and observe the process within.

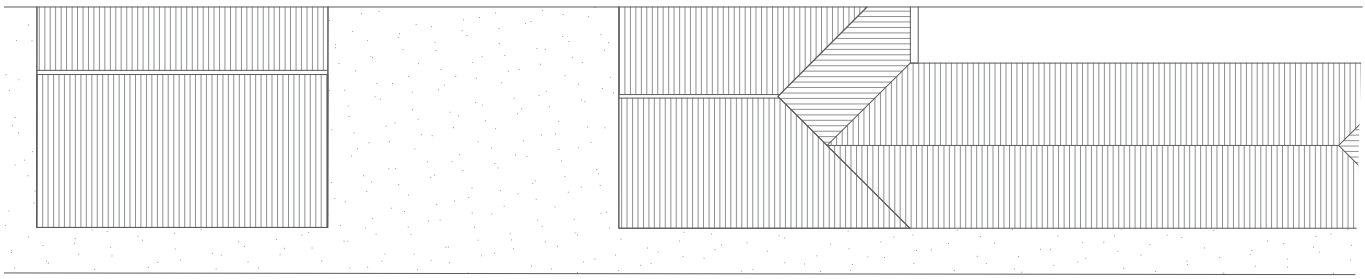


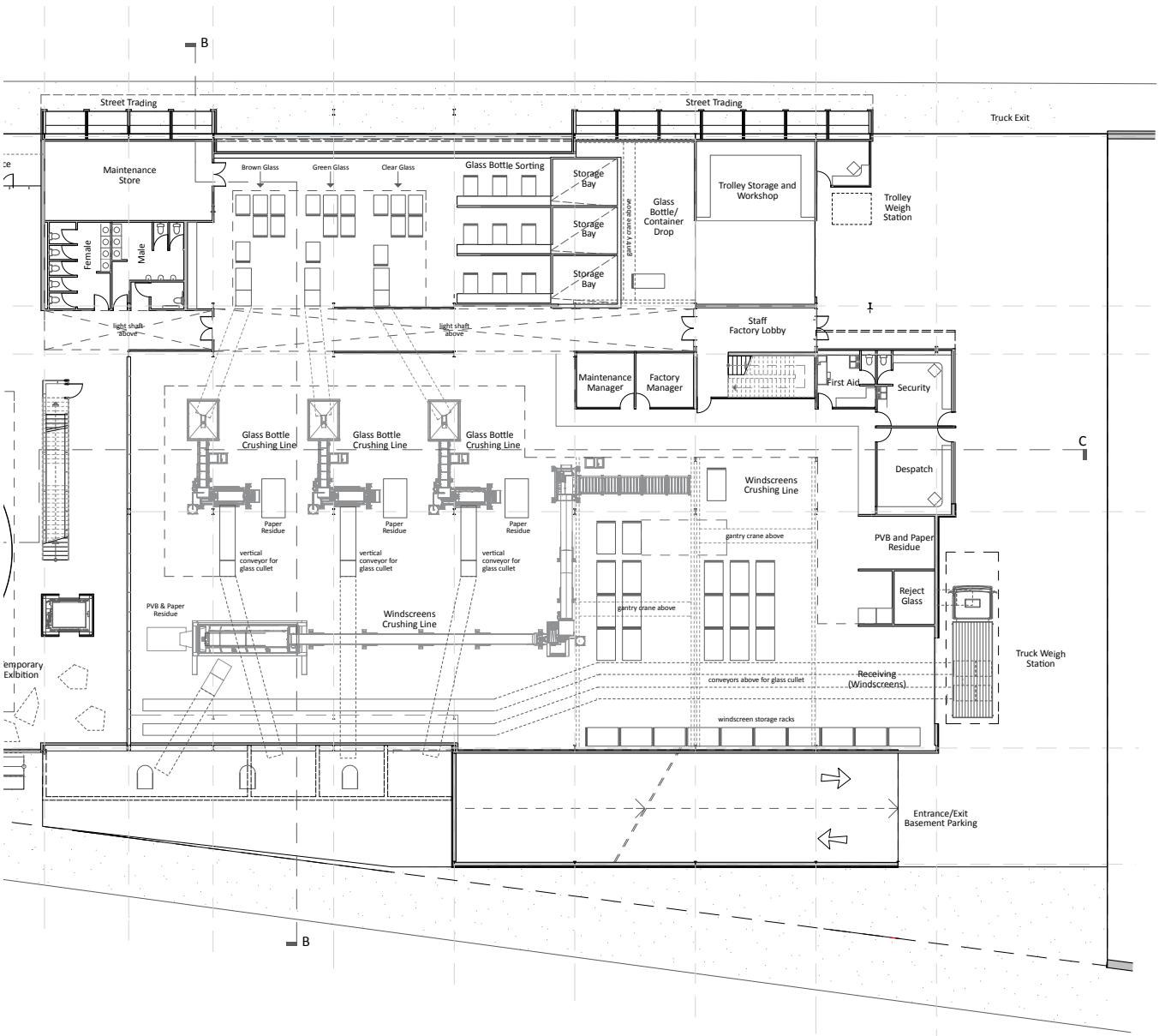
a. Factory Tectonic refers to the generic character of the factory. This being large span steel frame structure with infill of brick,timber or metal sheeting with external cladding of similar materials. Its purpose is create an enclosure where people and industrial process are arranged in a logical and systematic sequence within a large space. **b**. Glass Tectonic refers to the generic character of glass which is providing of views and experience. Its purpose is related to membrane but it also allows for viewing as well as for light to enter a space.

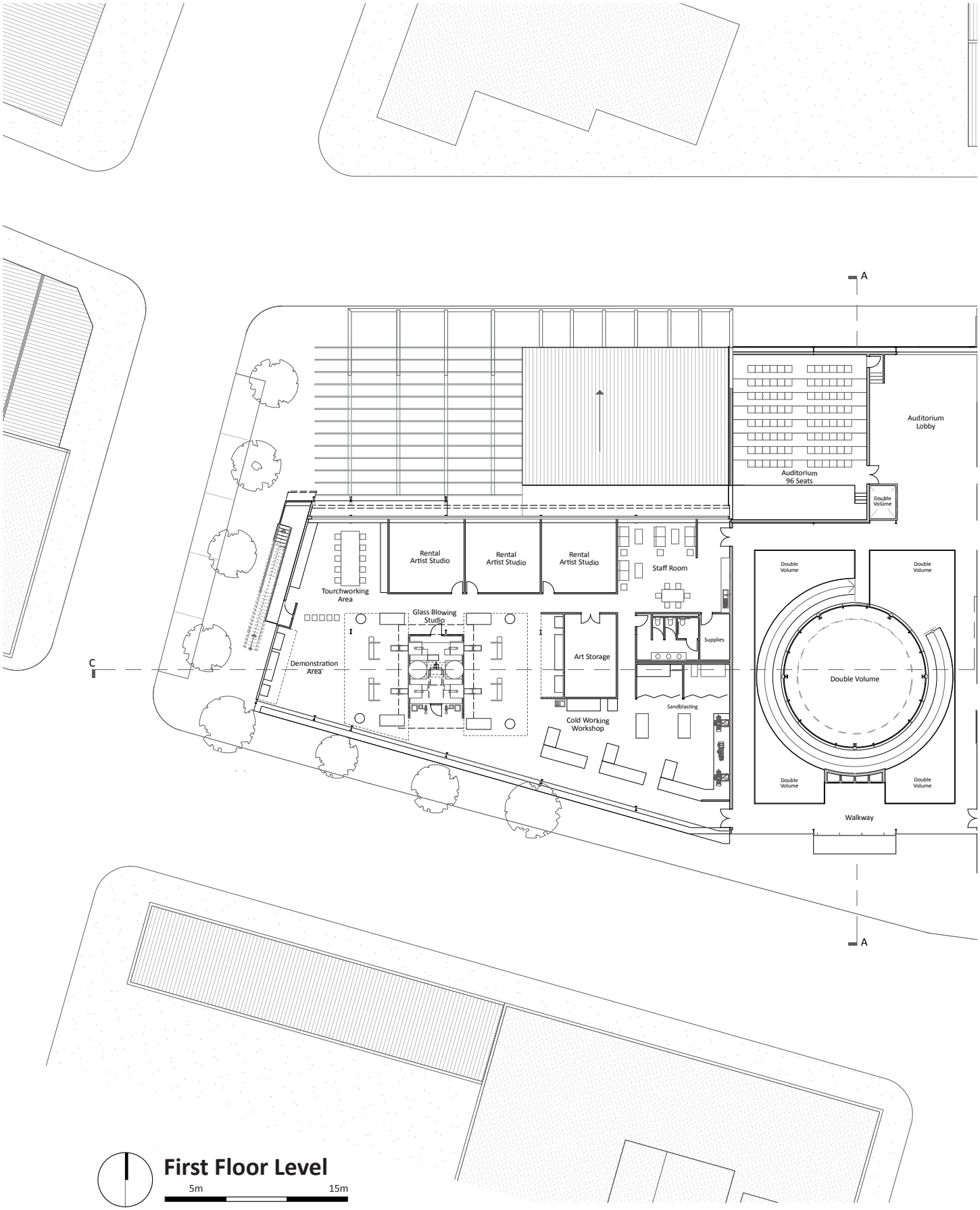


Ground Floor Level

5m 15m

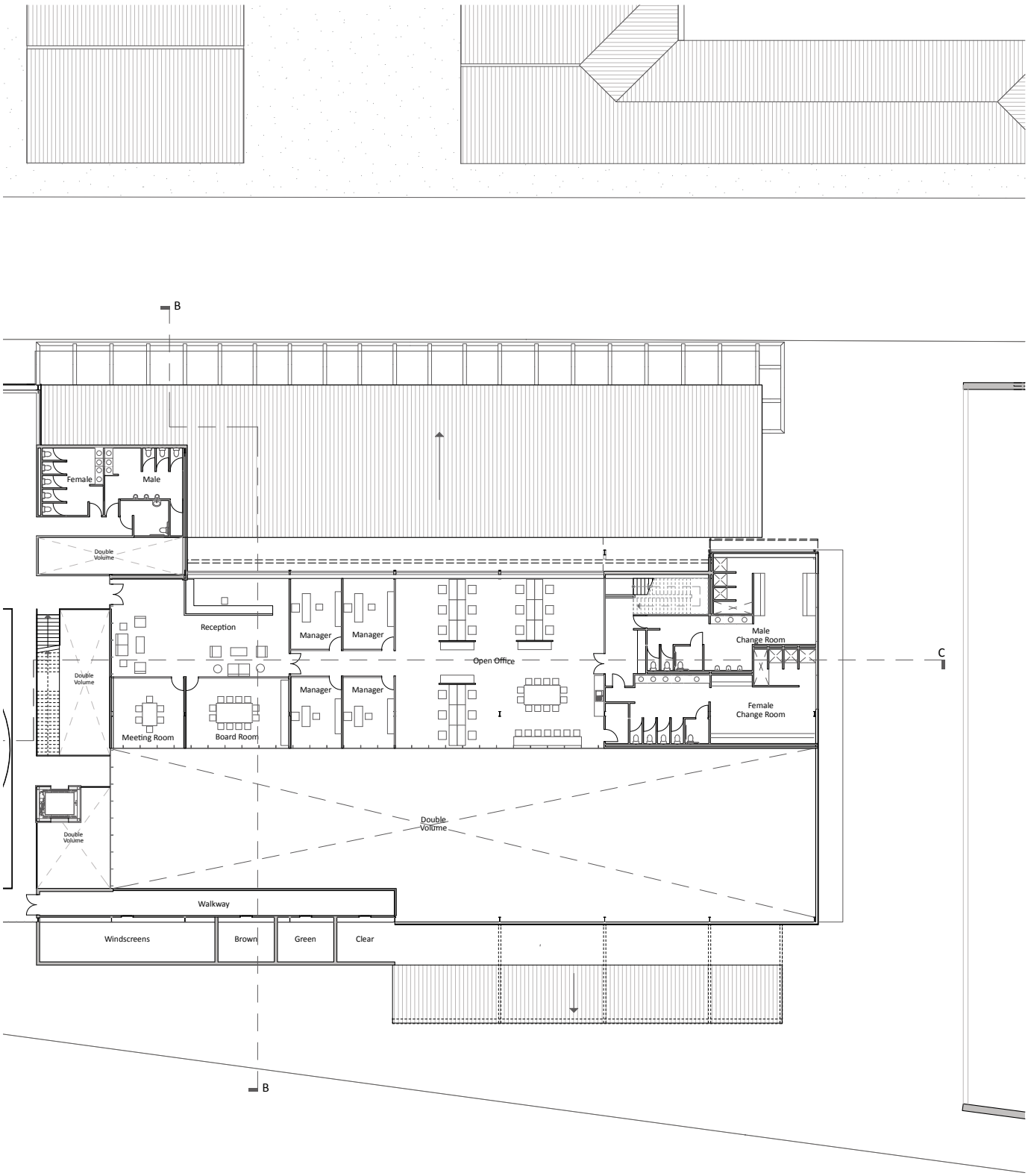


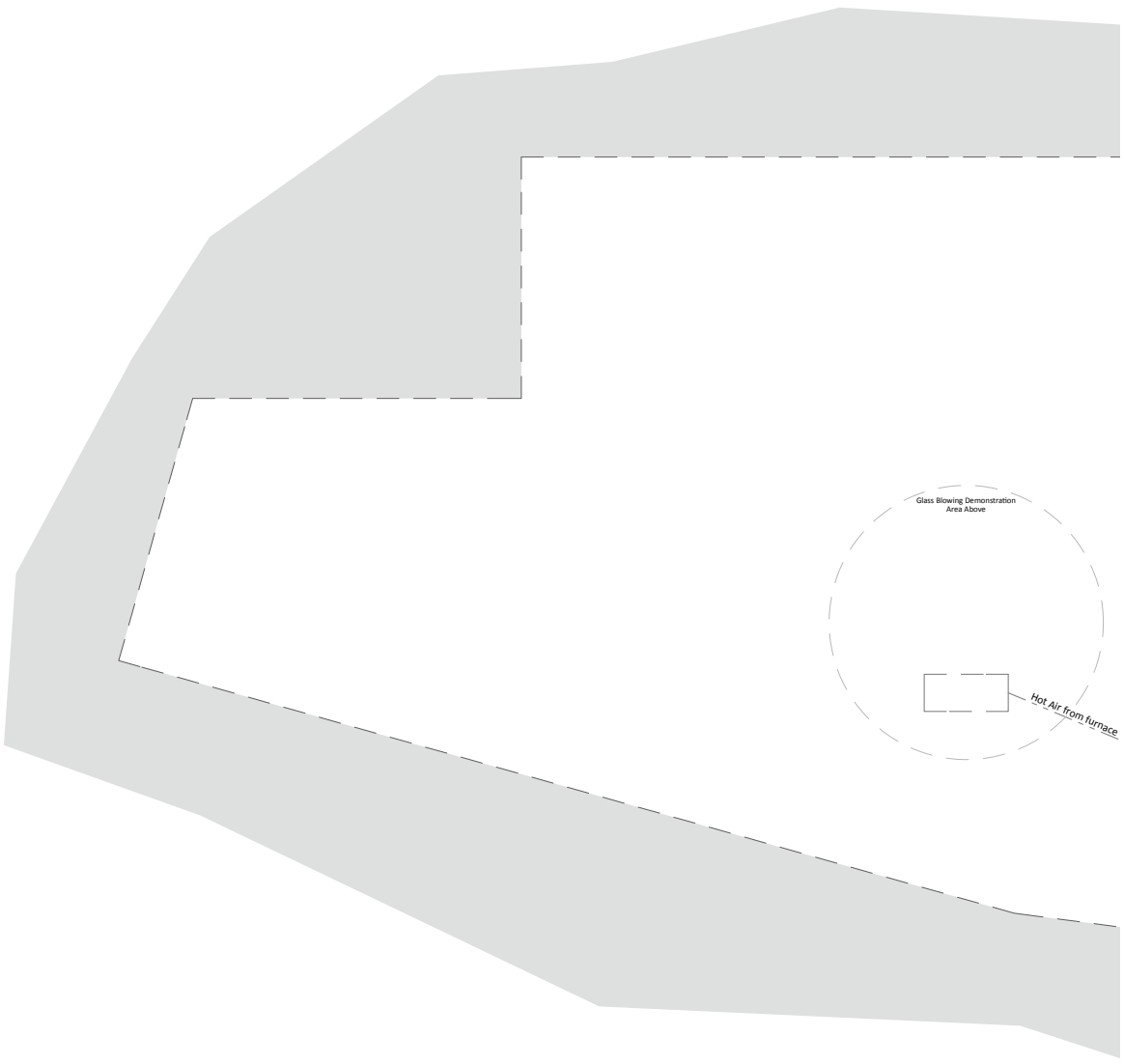

B
Street Trading
Street Trading
Truck Exit
Maintenance Store
Female
Male
Brown Glass
Green Glass
Clear Glass
Glass Bottle Sorting
Storage Bay
Storage Bay
Storage Bay
gantry crane above
Glass Bottle/ Container Drop
Trolley Storage and Workshop
Trolley Weigh Station
light shaft above
light shaft above
Staff Factory Lobby
Maintenance Manager
Factory Manager
First Aid
Security
C
Glass Bottle Crushing Line
Glass Bottle Crushing Line
Glass Bottle Crushing Line
Paper Residue
Paper Residue
Paper Residue
vertical conveyor for glass cullet
vertical conveyor for glass cullet
vertical conveyor for glass cullet
Windscreens Crushing Line
gantry crane above
Despatch
PVB and Paper Residue
Reject Glass
PVB & Paper Residue
Windscreens Crushing Line
gantry crane above
Truck Weigh Station
emporary Exibition
conveyors above for glass cullet
Receiving (Windscreens)
windscreen storage racks
Entrance/Exit Basement Parking
B



First Floor Level

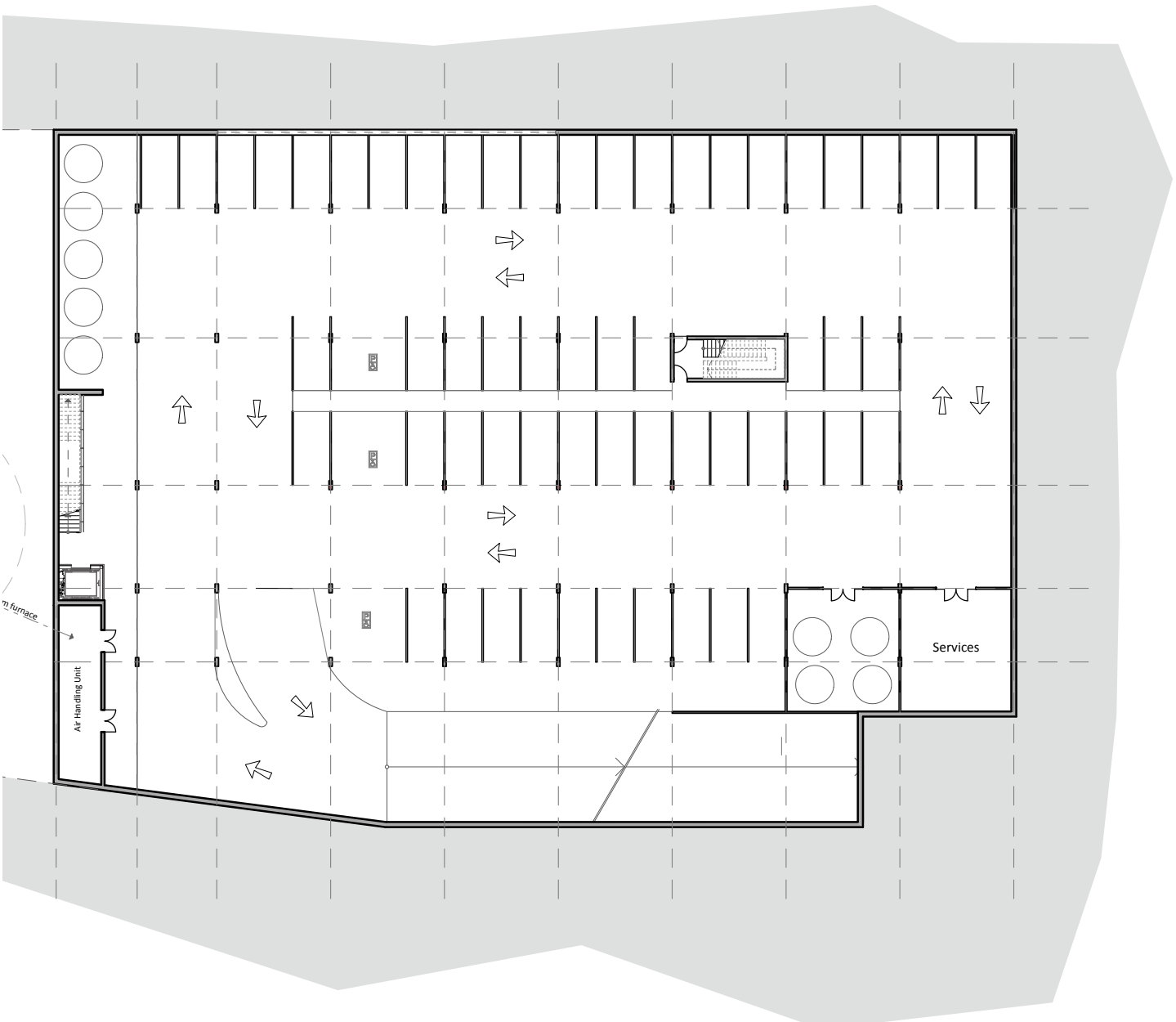
5m 15m

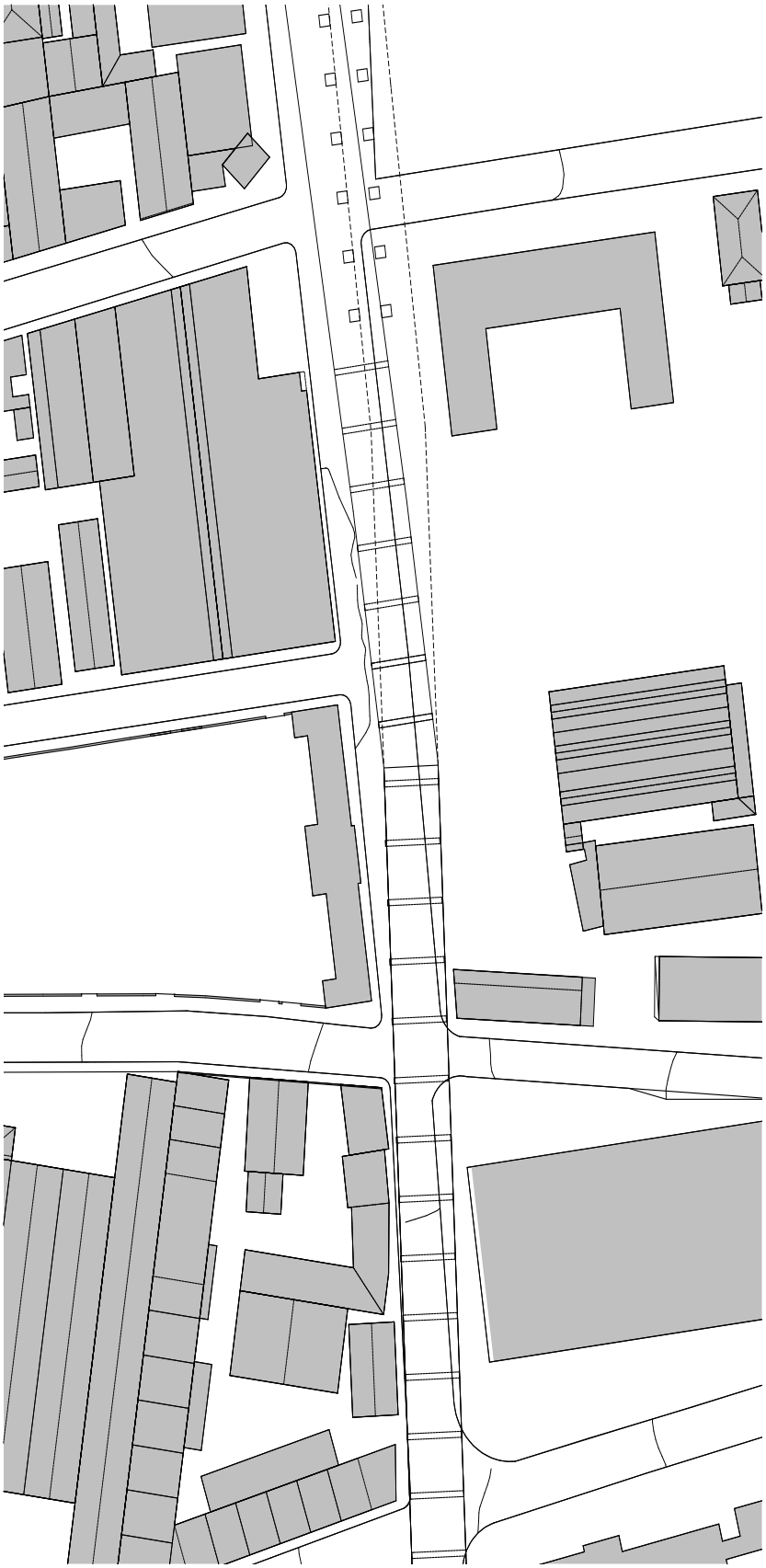

B
Female
Male
Double Volume
Reception
Manager
Manager
Open Office
Male Change Room
C
Double Volume
Manager
Manager
Female Change Room
Meeting Room
Board Room
Double Volume
Walkway
Windscreens
Brown
Green
Clear
B



Basement Level

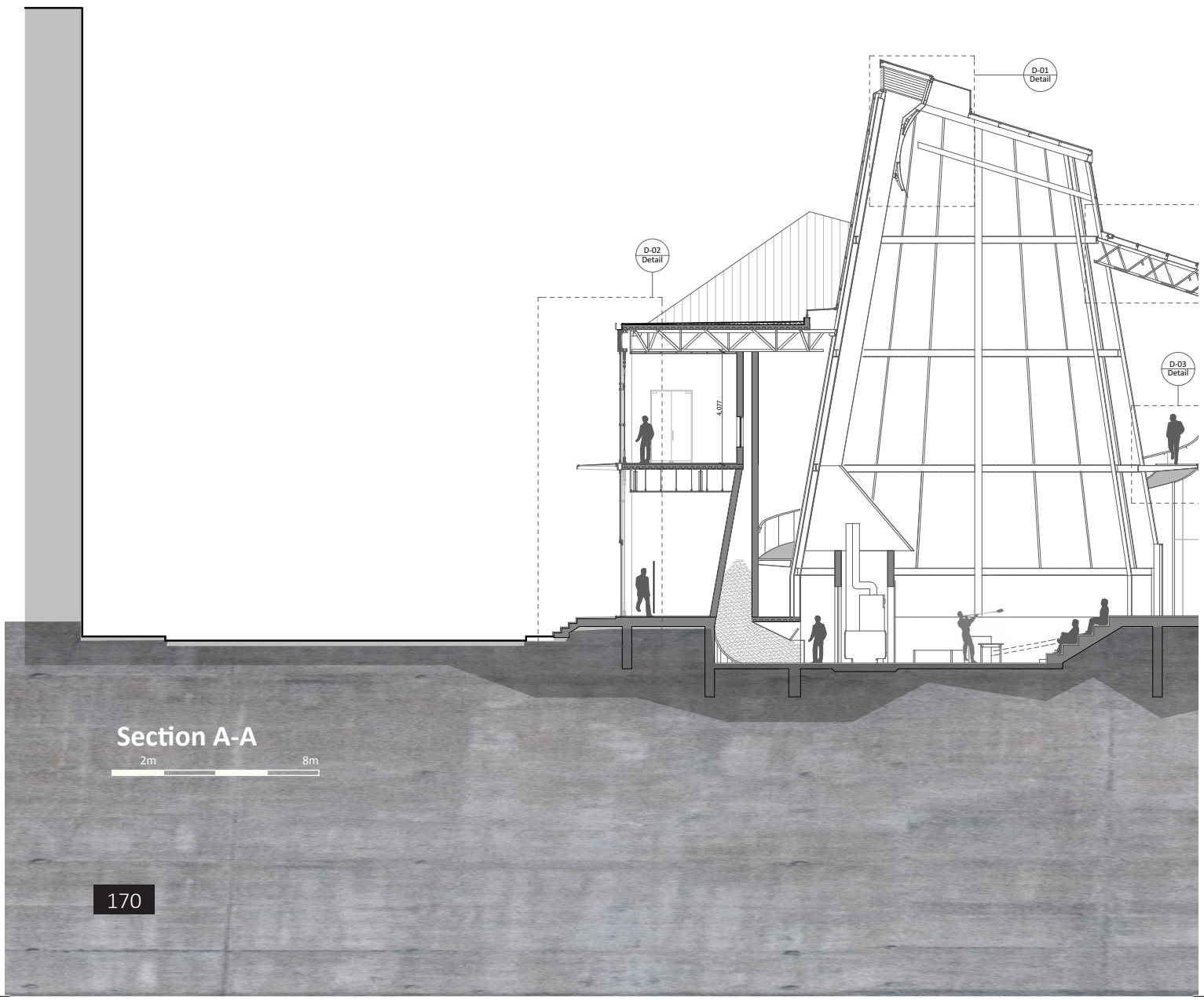
5m 15m


Air Handling Unit
Services



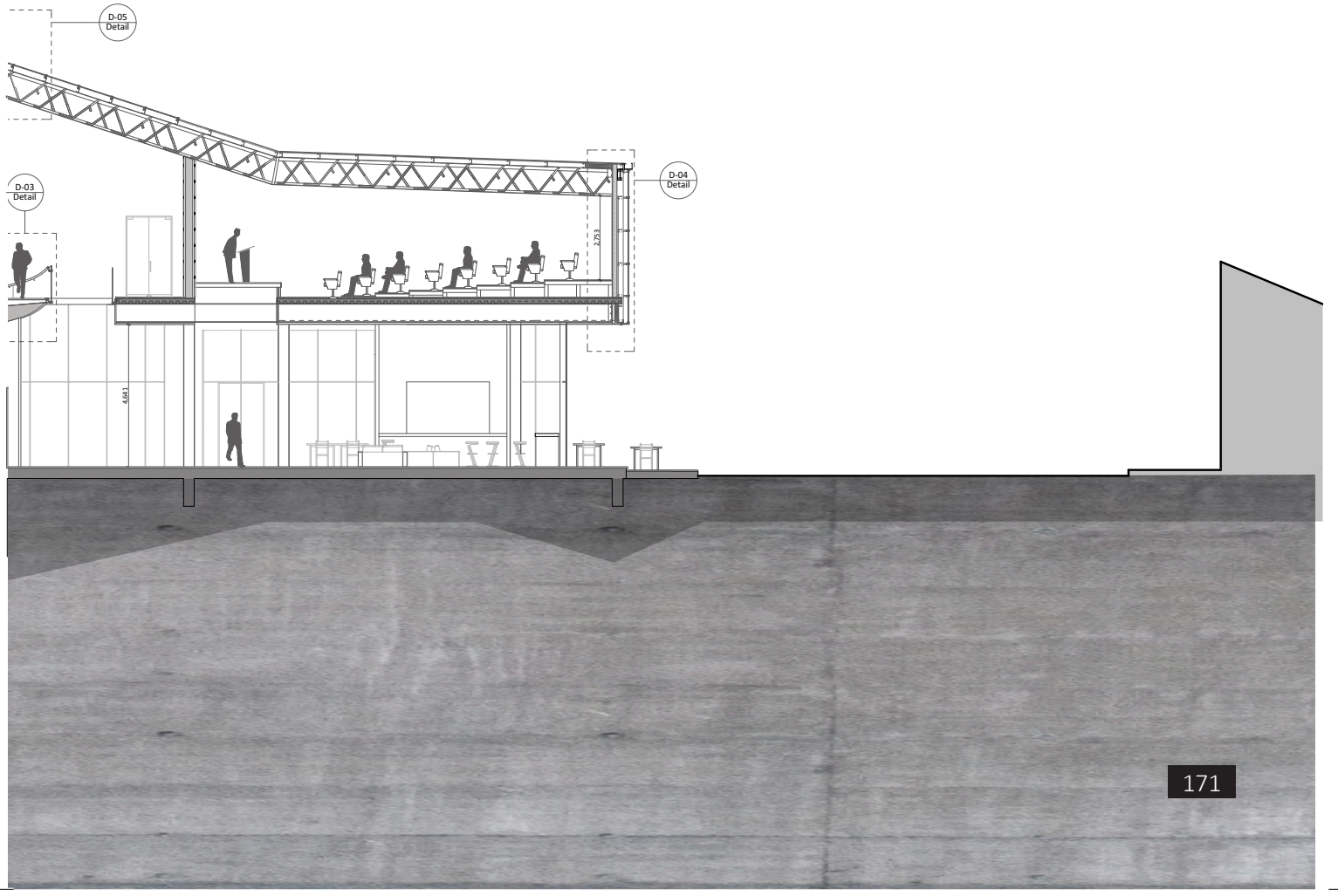
Site Plan

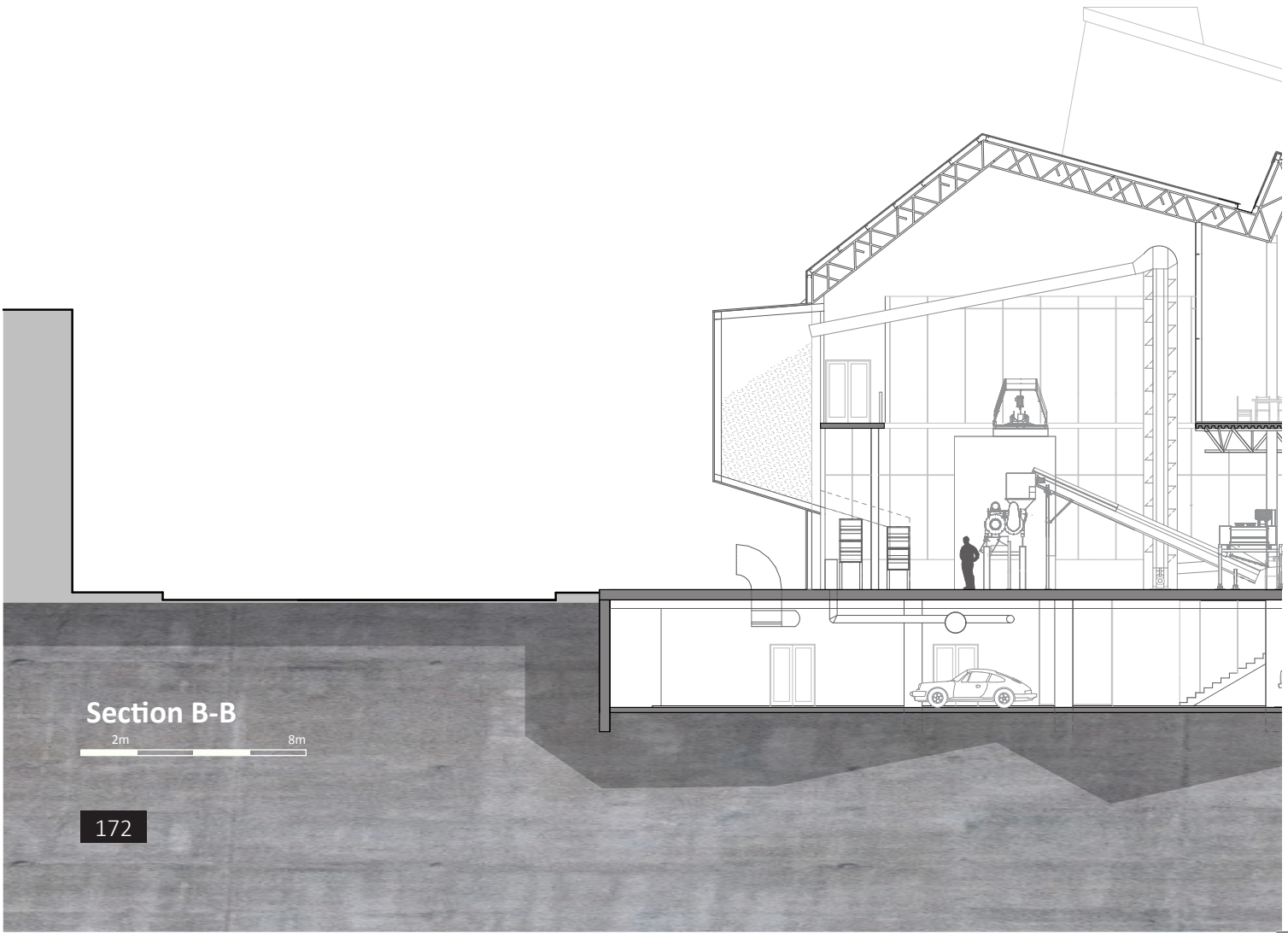
15m 45m



Section A-A

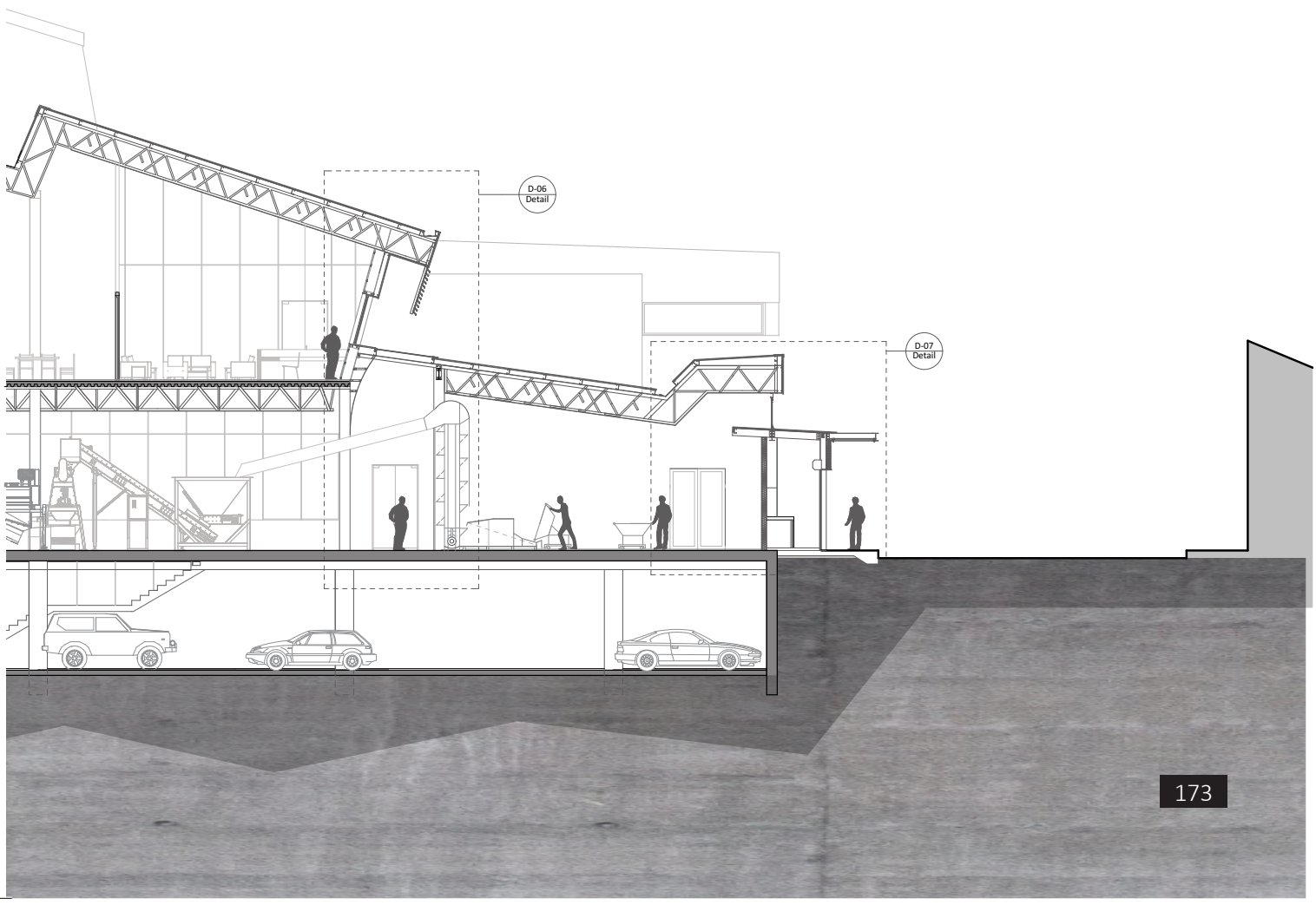
2m 8m

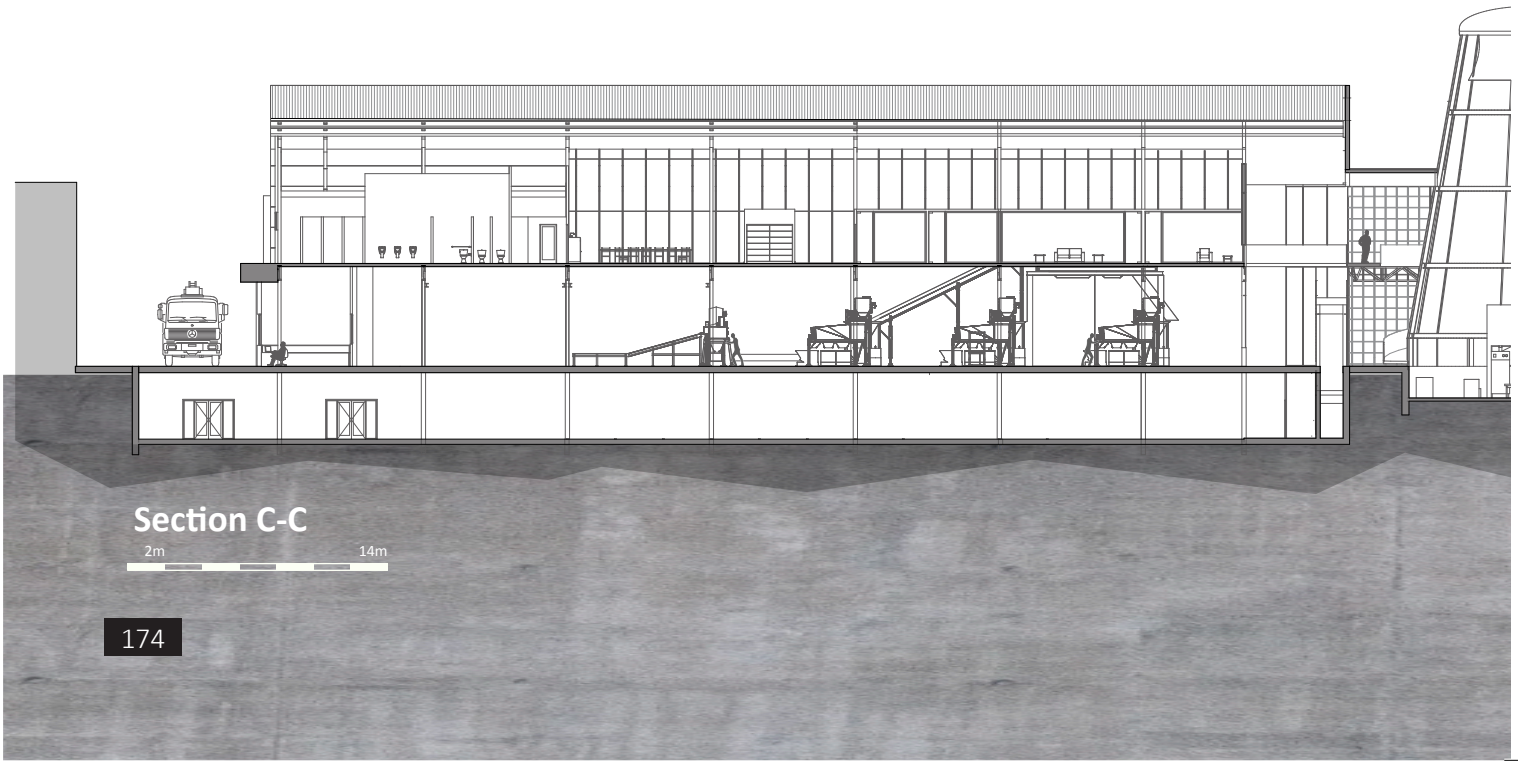

D-05
Detail
D-03
Detail
D-04
Detail
2,753
4641



Section B-B

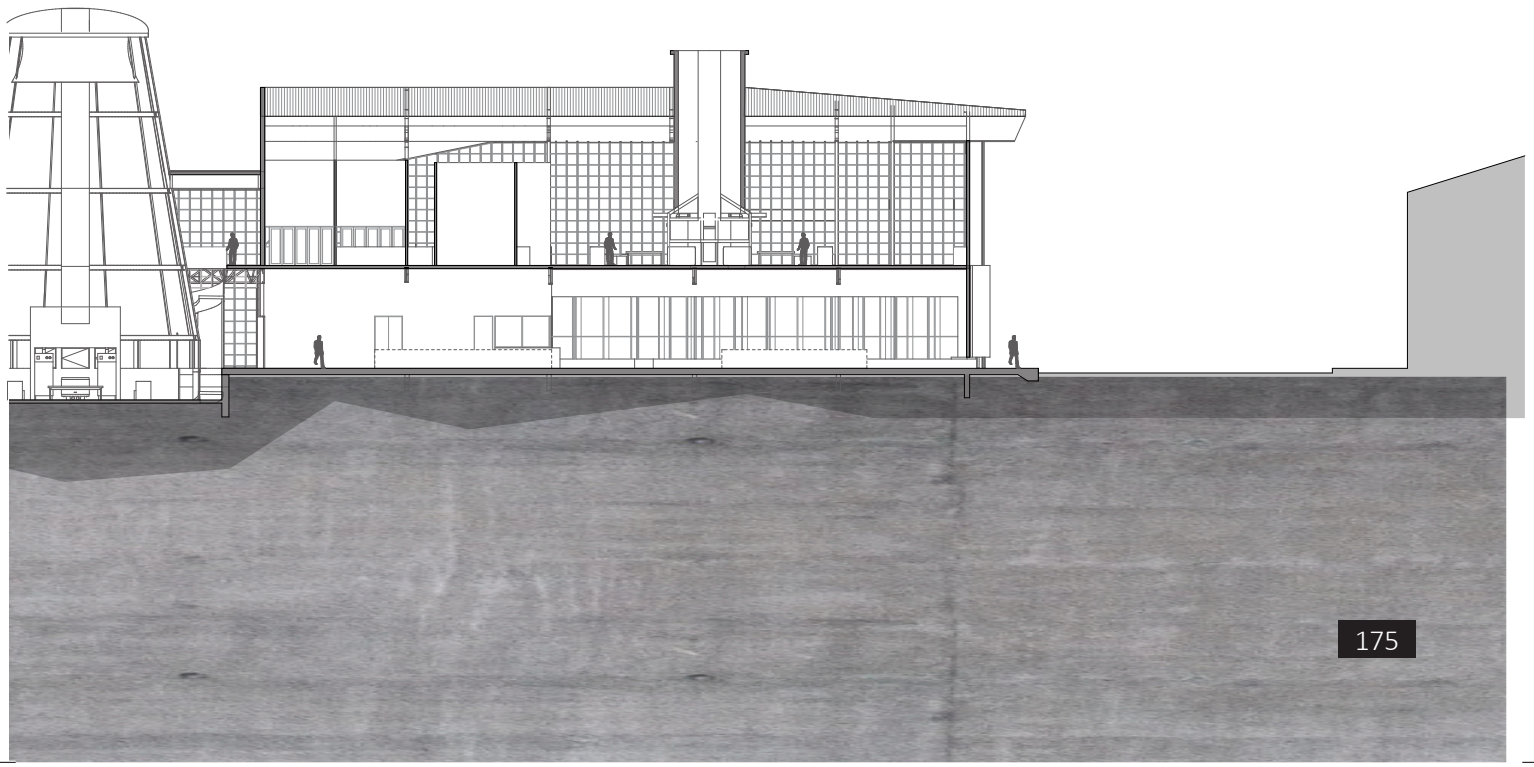
2m 8m

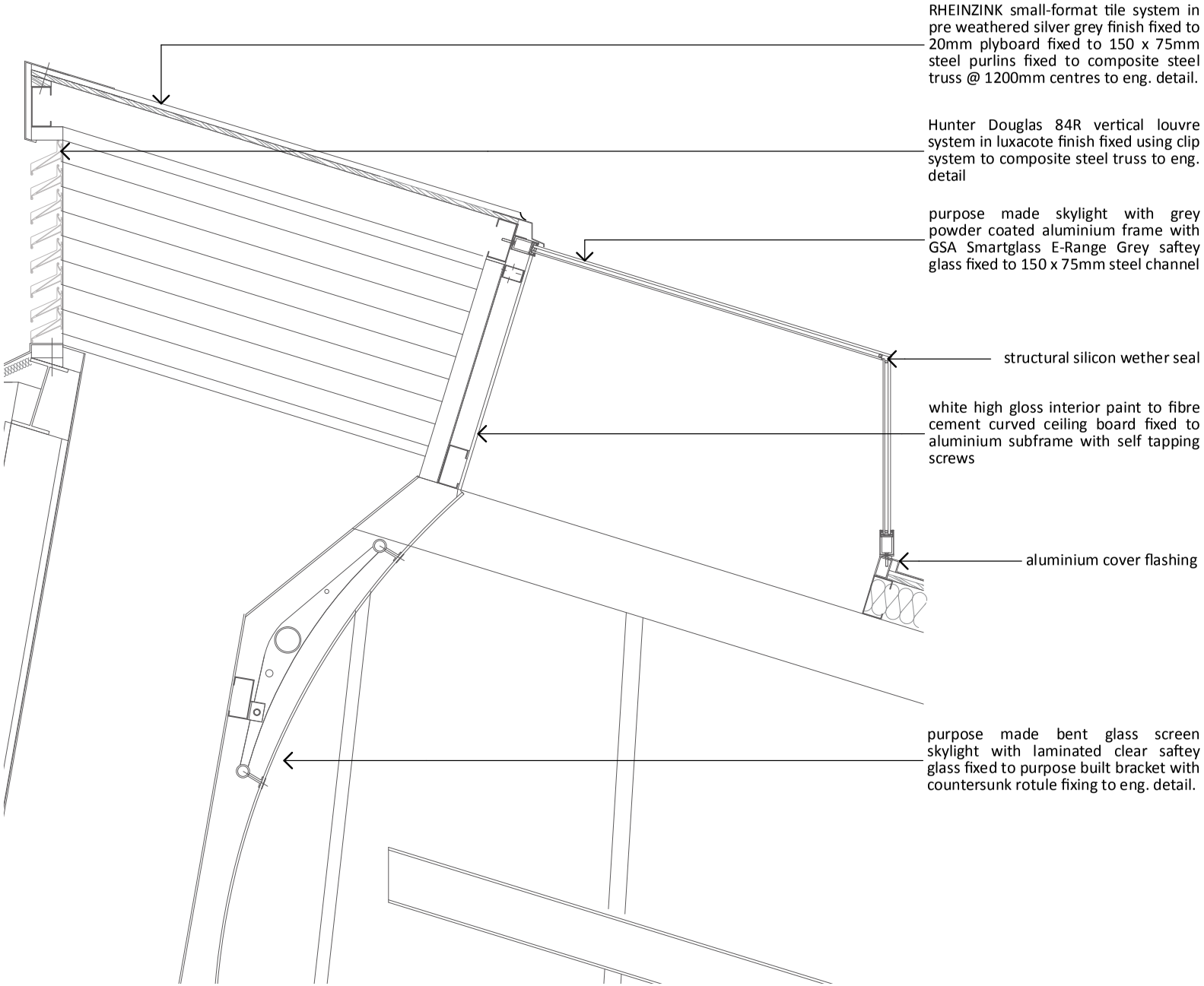

D-06
Detail
D-07
Detail

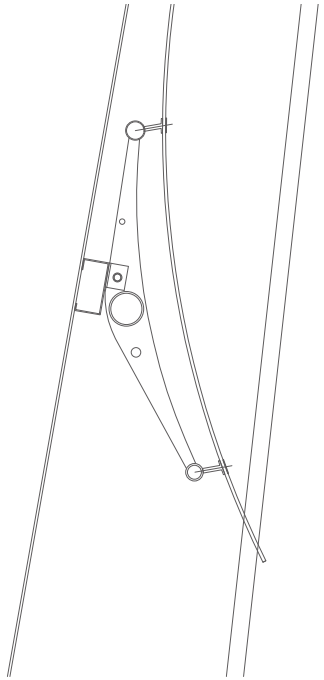


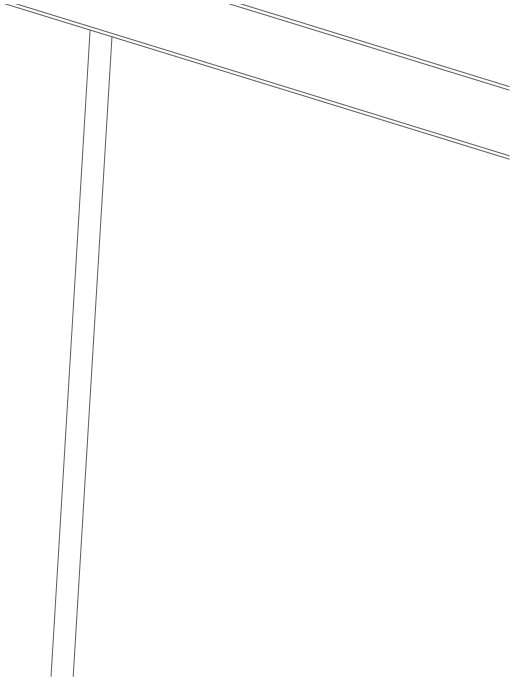
Section C-C

2m 14m

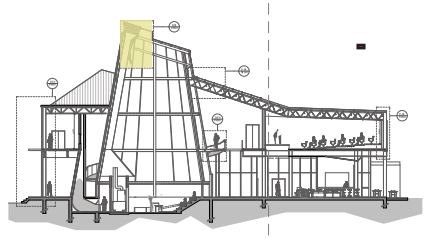



RHEINZINK small-format tile system in pre weathered silver grey finish fixed to 20mm plyboard fixed to 150 x 75mm steel purlins fixed to composite steel truss @ 1200mm centres to eng. detail.
Hunter Douglas 84R vertical louvre system in luxacote finish fixed using clip system to composite steel truss to eng. detail
purpose made skylight with grey powder coated aluminium frame with GSA Smartglass E-Range Grey saftey glass fixed to 150 x 75mm steel channel
structural silicon wether seal
white high gloss interior paint to fibre cement curved ceiling board fixed to aluminium subframe with self tapping screws
aluminium cover flashing
purpose made bent glass screen skylight with laminated clear saftey glass fixed to purpose built bracket with countersunk rotule fixing to eng. detail.





D01 Being in the Medium



One layer Derbigum SP4 waterproofing membrane, sealed to primed surface to falls by “torch-fusion”. 50mm thick layer of 19-25mm crusted stone on interdek separation layer on ComFlor 80 shallow steel composite profile deck fixed to composite steel beam to eng. detail

210 x 210mm purpose made aluminium gutter .

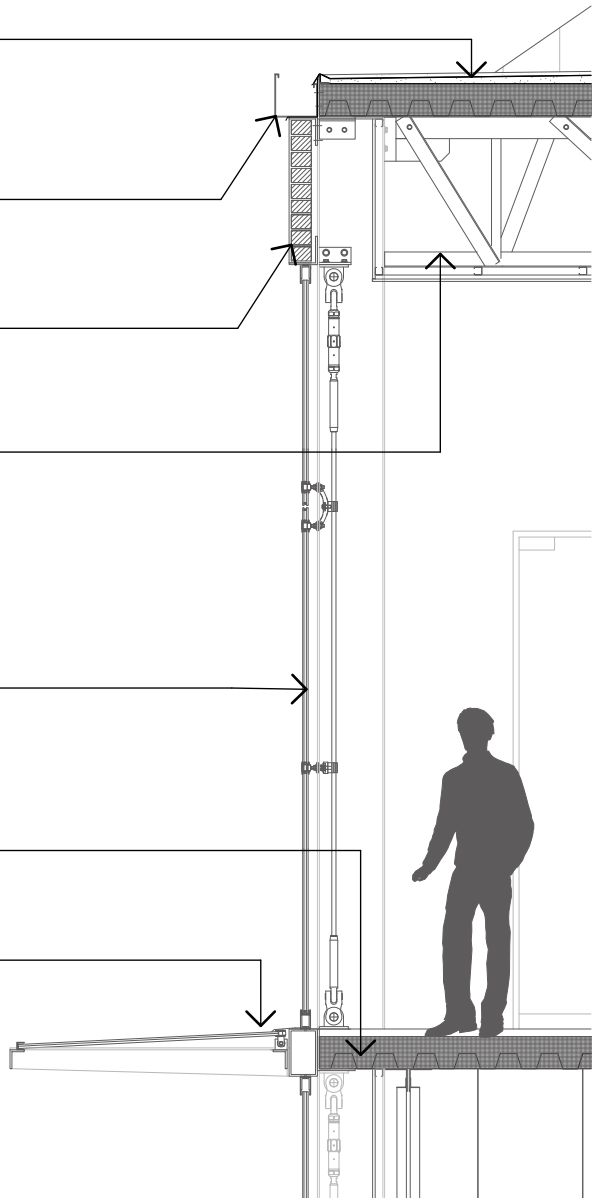
brick course laid on 150 x 150 mm steel angle with wall ties at three course intervals

composite steel truss fixed to steel plate fixed to 171 x 356 mm I-Beam column to eng. detail

spider fitting and cable clamp curtain wall assembly with GSA Smartglass E-Range Grey saftey glass fixed to tension cable system to specialist detail.

ComFlor 80 shallow steel composite profile deck fixed to composite steel beam to eng. detail

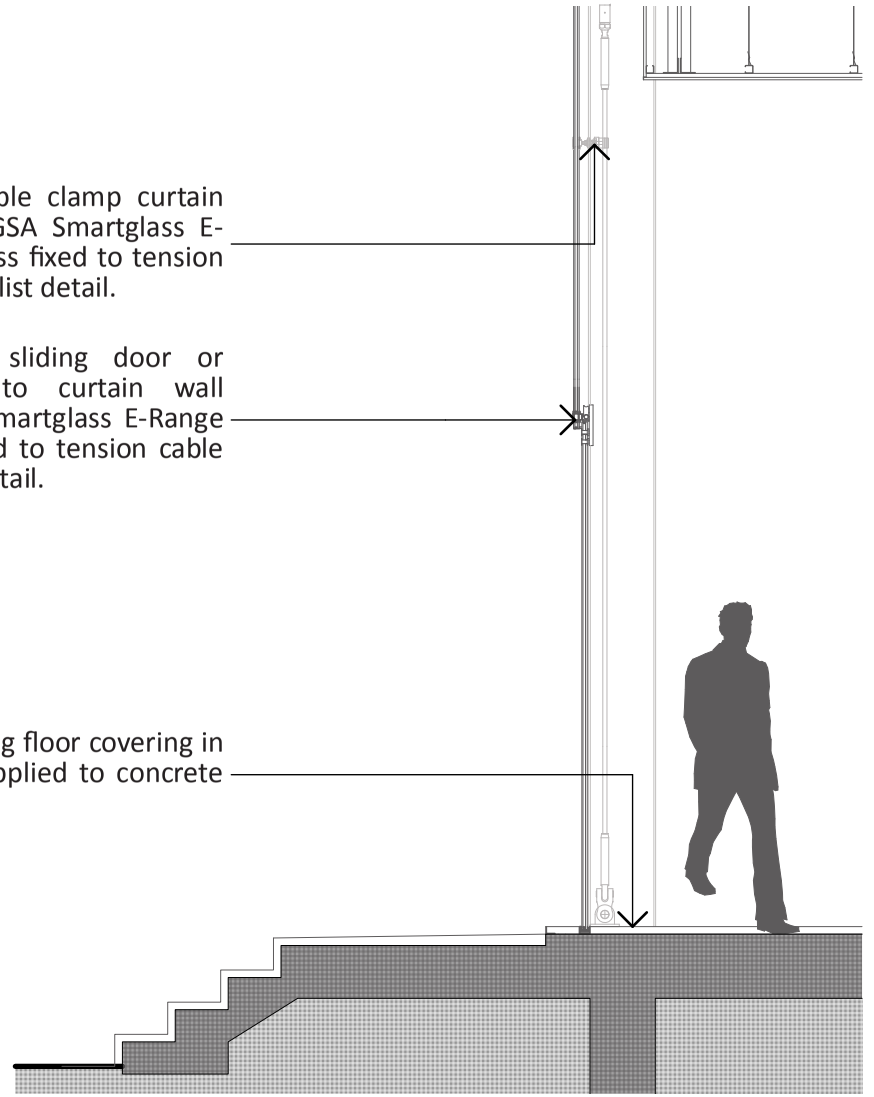
glass canopy to specialist detail

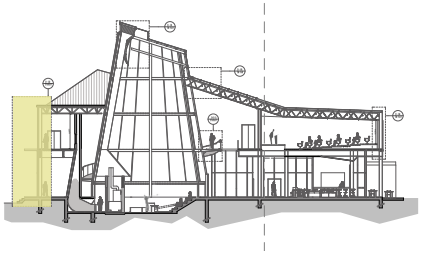


spider fitting and cable clamp curtain wall assembly with GSA Smartglass E-Range Grey saftey glass fixed to tension cable system to specialist detail.

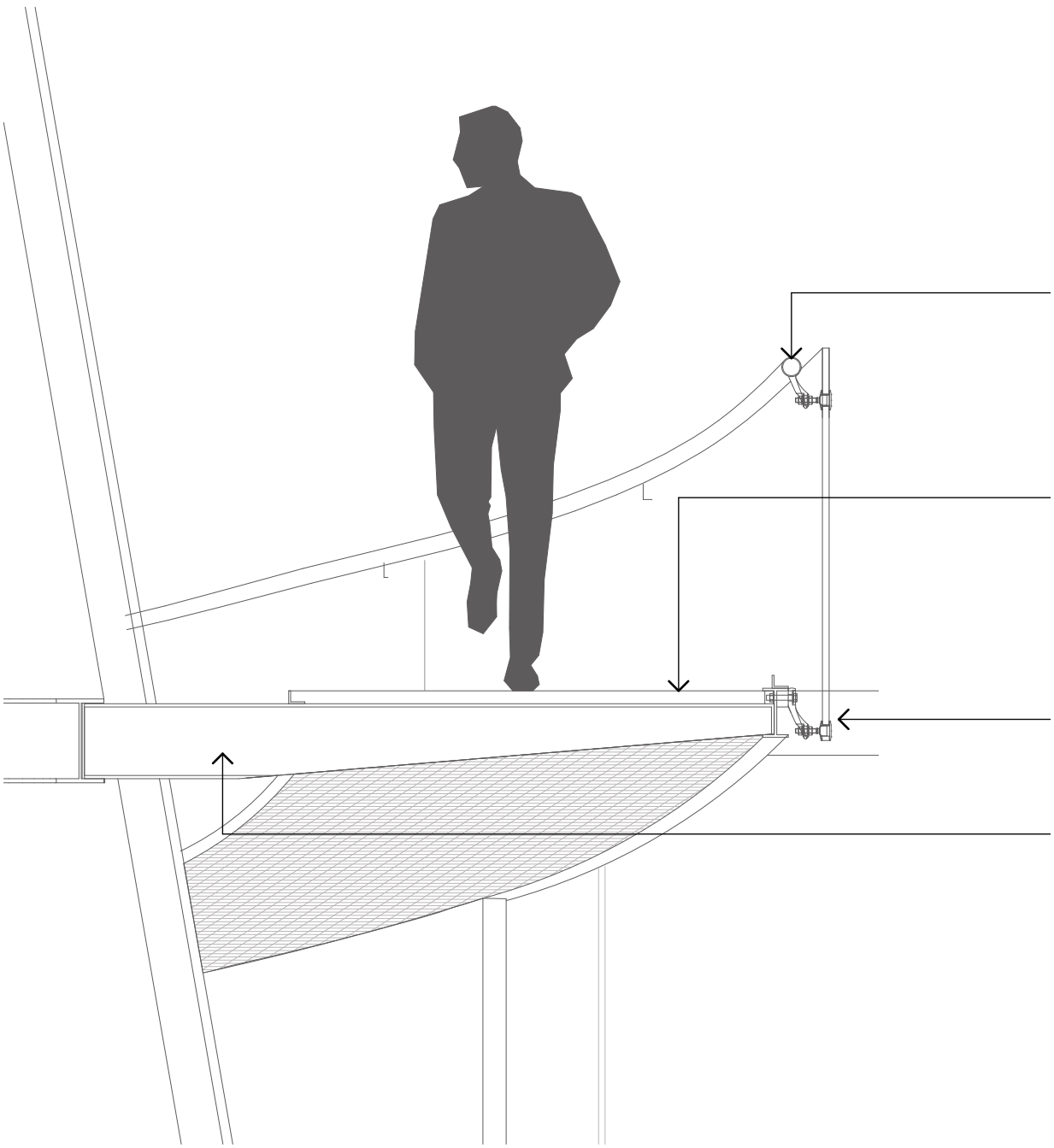
Hillaldam frameless sliding door or equivalent fixed to curtain wall assembly with GSA Smartglass E-Range Grey saftey glass fixed to tension cable system to specialist detail.

FloorCrete self-levelling floor covering in colour: Sand Dollar applied to concrete floor slab.





D02 - Shifting Perception with Glass Tectonics



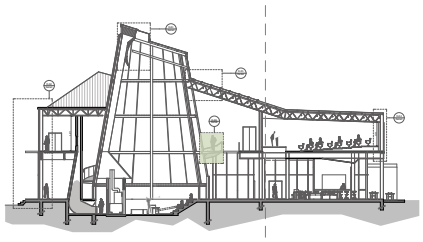
D03 - Movement and fluidity

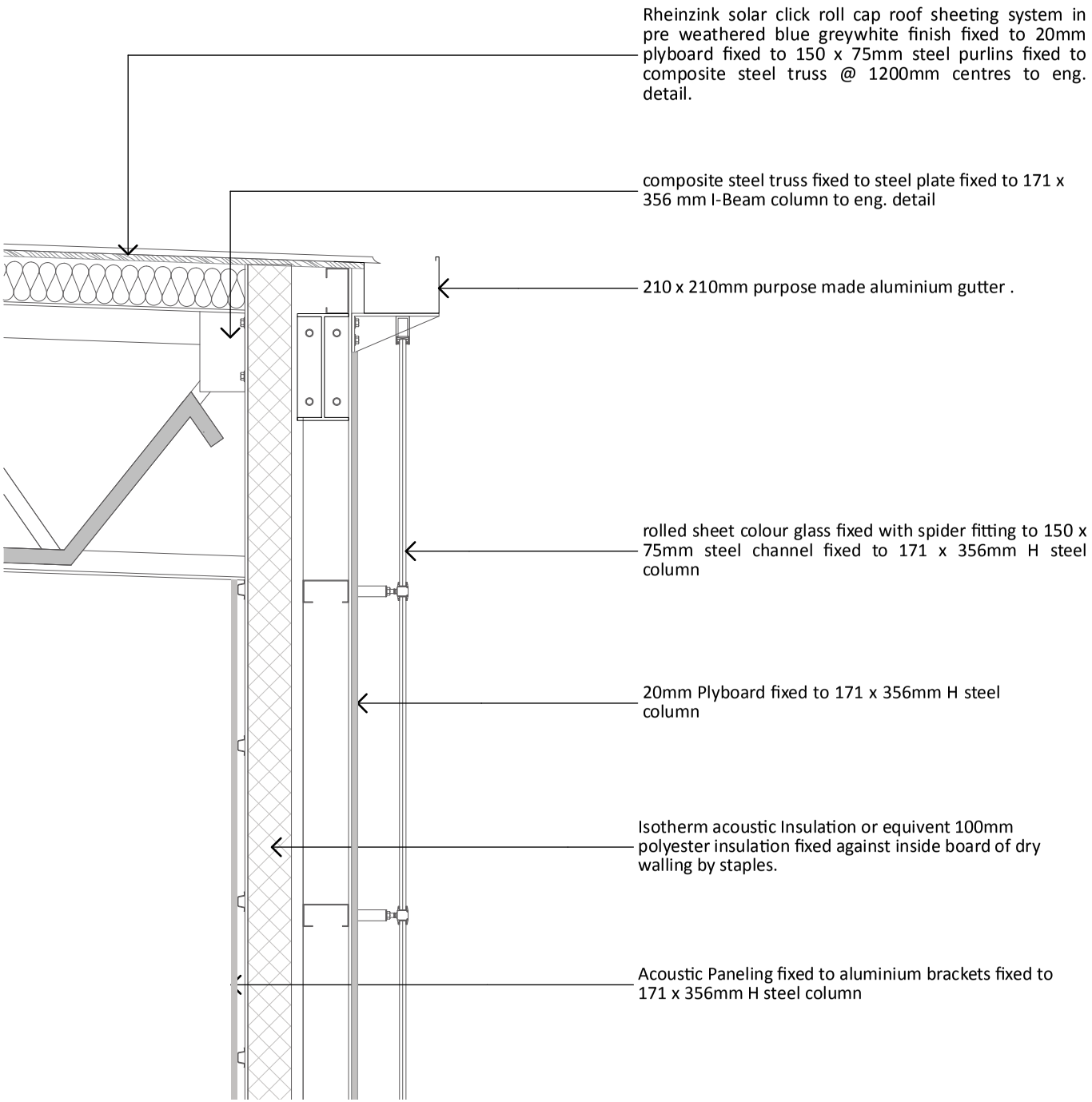
stainless steel hand rail fixed to spider clamp fixed saey glass fixed to 254 x 131 mm bent steel I-Beam to eng. Detail

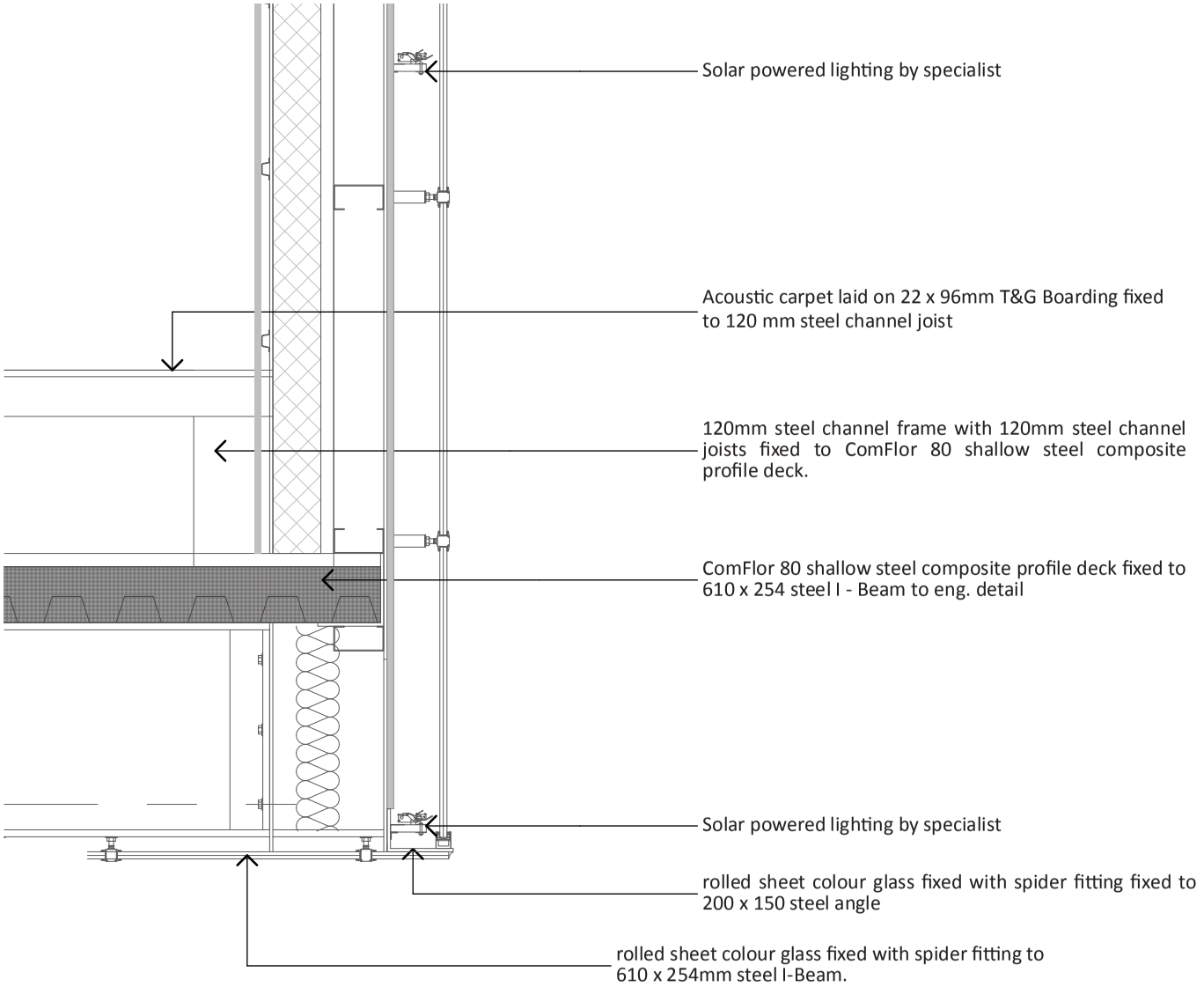
50 mm thick steel grang walkway fixed to 50mm steel angle fixed to 254 x 131 mm curved I-Beam to eng. detail

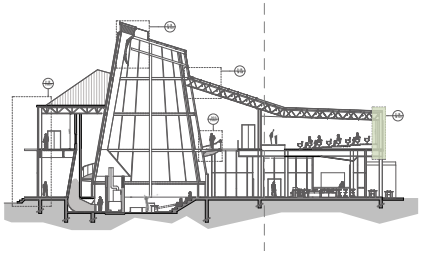
saey glass ballustrade fixed to spider clamp fixed to 254 x 131 mm bent steel I-Beam to eng. Detail

254 x 131 mm I-Beam support cut to eng. detail

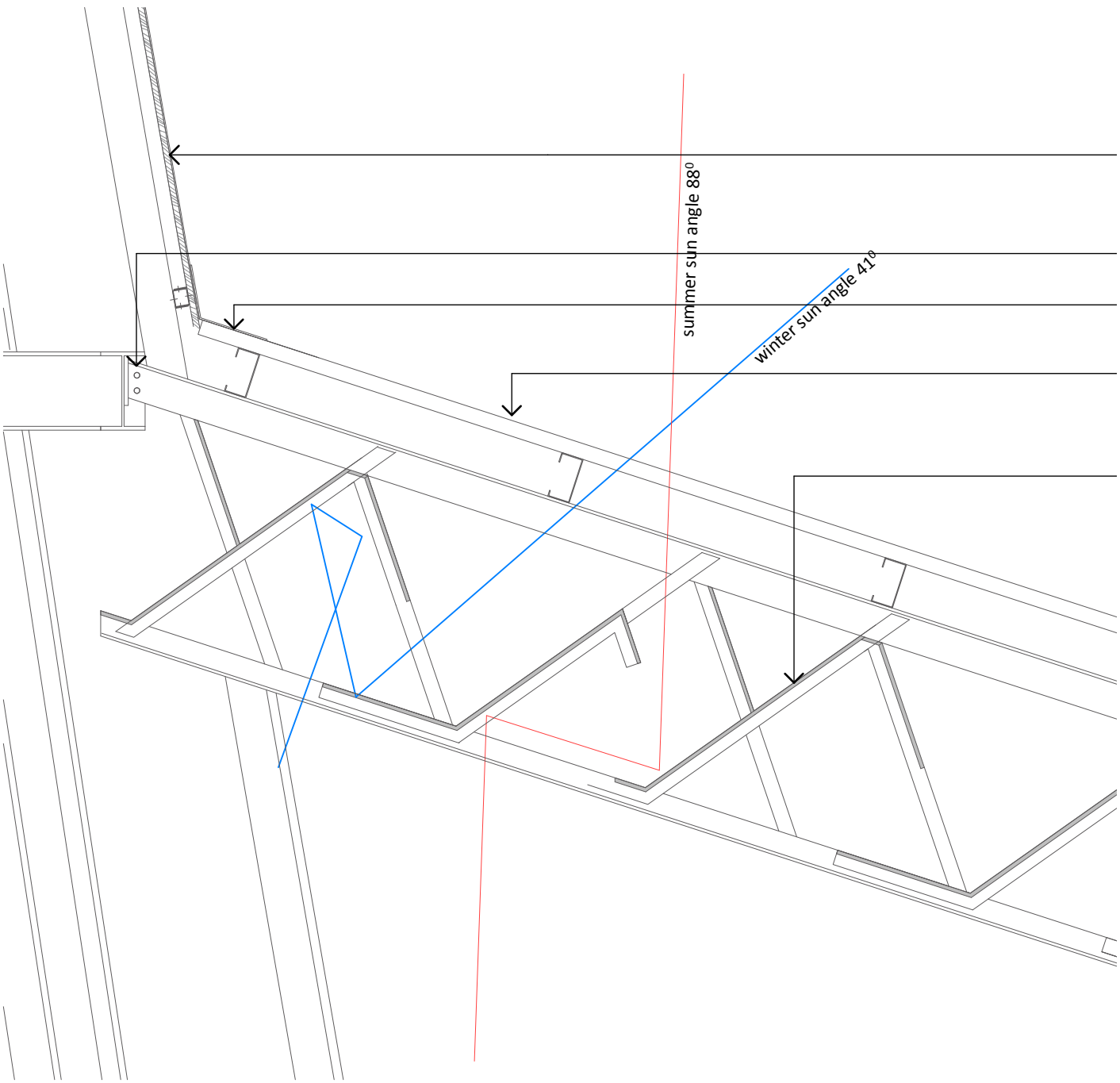



Rheinzink solar click roll cap roof sheeting system in pre weathered blue greywhite finish fixed to 20mm plyboard fixed to 150 x 75mm steel purlins fixed to composite steel truss @ 1200mm centres to eng. detail.
composite steel truss fixed to steel plate fixed to 171 x 356 mm I-Beam column to eng. detail
210 x 210mm purpose made aluminium gutter .
rolled sheet colour glass fixed with spider fitting to 150 x 75mm steel channel fixed to 171 x 356mm H steel column
20mm Plyboard fixed to 171 x 356mm H steel column
Isotherm acoustic Insulation or equivent 100mm polyester insulation fixed against inside board of dry walling by staples.
Acoustic Paneling fixed to aluminium brackets fixed to 171 x 356mm H steel column





D04 - Projection of craftsmanship



D05 -Movement and Fluidty

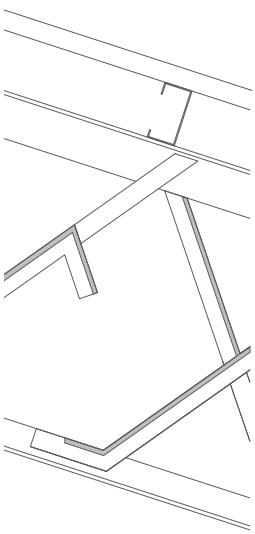
RHEINZINK small-format tile system in pre weathered silver grey finish fixed to 20mm plyboard fixed to 40 x 60 mm aluminium channels fixed to 150 x 75mm steel purlins fixed to composite steel truss @ 1200mm centres to eng. detail.

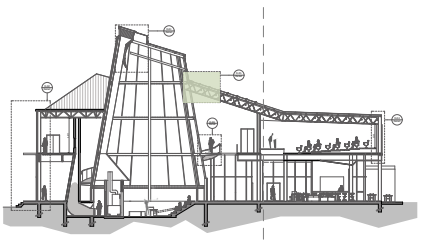
composite steel truss fixed to 254 x 146 x 31 bent steel I-Beam to eng. detail

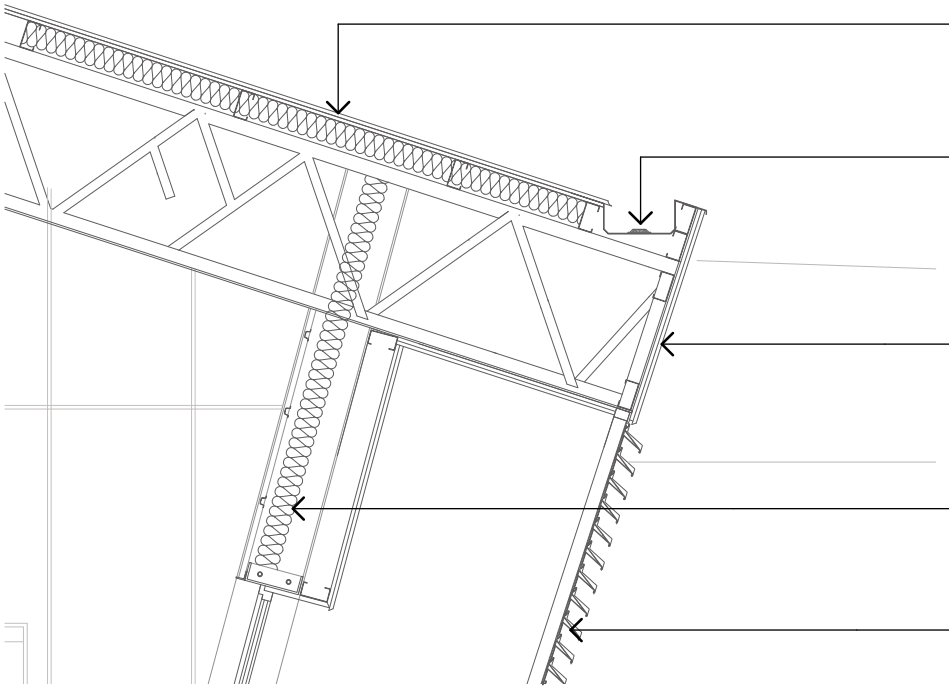
RHEINZINK small-format tile system purpose made flashing

Tuflite or equivalent Corrugated Polycarbonate Sheet with dual UV coating fixed to 150 x 75mm steel channel with outside disc boltdown spider fixing.

purpose made aluminium panels fixed to composite truss to architects design and eng. detail







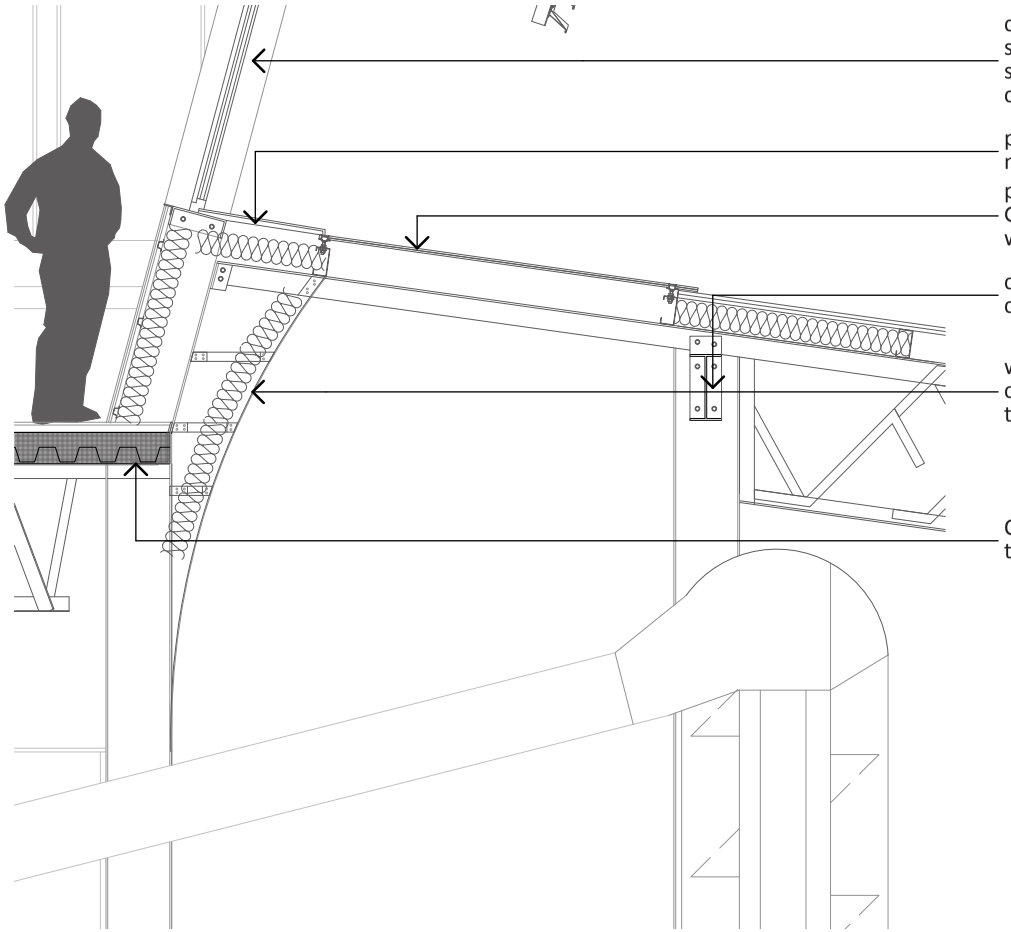
Rheinzink solar click roll cap roof sheeting System in pre weathered blue greywhite finish fixed to 2omm plyboard fixed to 150 x 75mm steel purlins fixed to composite steel truss @ 1200mm centres to eng. detail.

Pluvia roof outlet,with tray 25 l/s, stainless steel 60 x 60mm, incl.contact sheet fixed to purpose made aluminium gutter.

Rheinzink solar click roll cap roof sheeting System in pre weathered blue greywhite finish fixed vertically to 20mm plyboard fixed to 150 x 75mm steel Purlins fixed to composite steel truss @ 900mm centres to eng. detail.

Isotherm Thermal Insulation or equivent 100mm polyester thermal insulation fixed against inside board of dry walling by staples.

Hunter Douglas 84R vertical louvre system in luxacote finish fixed using clip system to composite steel truss to eng. detail



custom made dark grey powder coated aluminium sliding window with GSA Smartglass E-Range Grey saftey glass fixed to underside of 300 x 100mm steel channel bolted to 171 x 356mm I-Beam column.

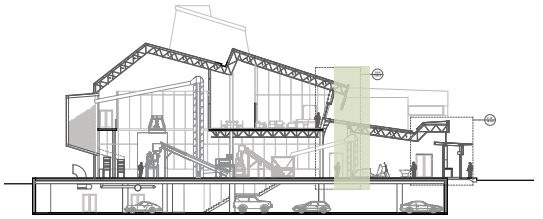
purpose made aluminium fashing fixed to 300x 100 mm steel channel

purpose made skylight with GSA Smartglass E-Range Grey saftey glass fixed to 150 x 75mm steel channel with countersunk rotule fixing.

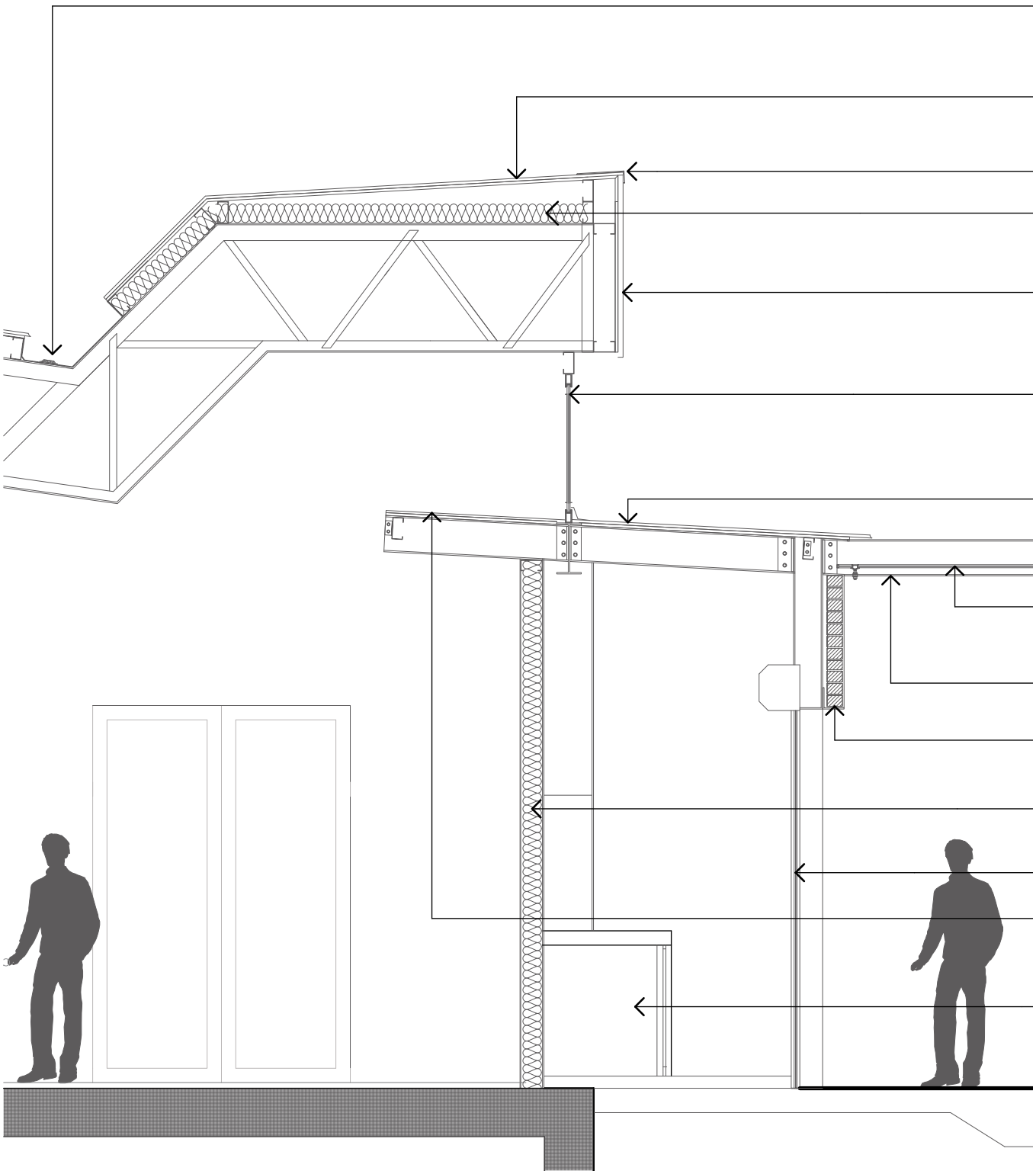
composite steel truss fixed to 171 x 356 mm I-Beam column and beam

white high gloss interior paint to fibre cement curved ceiling board fixed to aluminium subframe with self tapping screws

ComFlor 80 shallow steel composite profile deck fixed to composite steel beam to eng. detail



D06 - Central connection of movement



D07 - Threshold of Connection

Pluvia roof outlet,with tray 25 l/s, stainless steel 60 x 60cm, incl.contact sheet fixed to purpose made aluminium box gutter.

Rheinzink solar click roll cap roof sheeting system in pre weathered blue greywhite finish fixed to 20mm plyboard fixed to 150 x 75mm steel purlins fixed to composite steel truss @ 1200mm centres to eng. detail.

pre weathered blue greywhite finish aluminium flashing.

Think Pink Aerolite ceiling insulation 50mm thick laid over composite steel truss

Rheinzink solar click roll cap roof sheeting System in pre weathered blue greywhite finish fixed vertically to 20mm plyboard fixed to 150 x 75mm steel Purlins fixed to composite steel truss @ 900mm centres to eng. detail.

custom made dark grey powder coated aluminium fixed pane clerestory window fixed to underside of 150 x 75mm steel and the top of 171 x 345 I- Beam

Rheinzink solar click roll cap roof sheeting System in pre weathered blue greywhite finish fixed to 20mm plyboard fixed to 150 x 75mm steel Purlins fixed to composite steel truss @ 900mm centres to eng. detail.

rolled sheet colour glass fixed with spider fitting to 254 x 146mm I-Beam

254 x 146 x 31 steel I-Beam end eave to eng. detail bolted to 203 x 133 I-Beam column

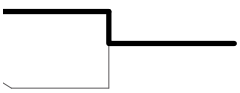
brick course laid on 150 x 150 mm steel angle with wall ties at three course intervals

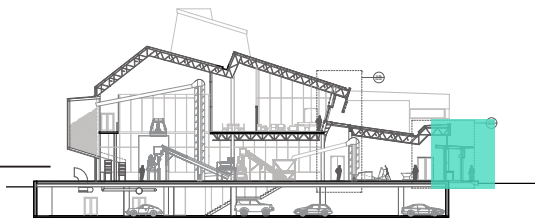
Isotherm Thermal Insulation or equivent 100mm polyester thermal insulation fixed against inside board of dry walling by staples.

2500mm x 2100mm aluminium roll- up garage door

white high gloss interior paint to fibre cement ceiling board fixed to purlin with self tapping screws

Storage cupboard for glass products being sold.





08 |

CONCLUSION

The aim of this thesis was investigate the current waste recycling system within the city of Johannesburg and explore how this system could be enhanced by the integration of informal and formal recycling sectors, by creating an opportunity for the Waste Reclaimers to become an official and recognized part of the process of recycling.

The recycling industry is volatile to fluctuations in price changes for the recyclables collected. The Waste Reclaimers are particularly vulnerable to these volatile fluctuations as they rely solely on the collection of recyclable waste. The endlessly recycling nature of glass and its age old process of manufacturing provided an opportunity to develop a place of craftmanship and exchange. It provided the Waste Reclaimers with the opportunity to be able to engage in the material of glass from collection to the manufacturing of glass product. This space generates social learning through the opportunity to view, experience and become evolved in the entire process of glass recycling. This will therefore increase skills and development and provide a wider spectrum of opportunity for social and economic mobility.

The site in Newtown was carefully selected taking into consideration the existing movement network of the existing informal waste collectors and the relative buy-back centres that they use. The site was selected due to its central location within this network and its visibility to the cultural precinct of Newtown and the Oriental Plaza. It therefore created the opportunity for these paths to converged where the general public and the recyclers will interact. The site also offers a unique combination of light industrial and mixed-use zoning within a cultural precinct. This therefore presented the opportunity to explore a building design that challenges the notion of an industrial process being confined and restricted to an “industrial shed” stripped bare to its functional needs with its workers being atomized units engaged in a single specialized skill set. The building design creates a space that reveals and showcases the beauty of an industrial process and the art of making assisting in creating a public awareness of the recycling industry. The design explored the idea of the building becoming a medium between a functional and experiential architecture through the application of the principal of tectonics. It therefore creates an environment that nurtures transformation of both participant and medium.

A building of this nature may not resolve the complexity of the topic however, it gives a platform to consider the possibilities that architecture offers by creating opportunities to create meaningful and beneficial relationships between its users and the activities that it contains.

REFERENCES

ALEXANDER, C. 1964. Notes on the Synthesis of Form, Harvard University Press.

BRAUNGART, M. & MCDONOUGH, W. 2008. Cradle to Cradle. Re-Making the way we make things, London, Vintage Books.

CASEY, B., DODGE, J. & H, D. 2010. Henry Ford and Innovation. Available: http://www.thehenryford.org/education/erb/HenryFordAndInnovation.pdf [Accessed 22/10/2014].

CHING, F. 1979. Architecture: Form Space and Order, New York, Van Nostrand Reinhold Company.

THE GLASS RECYCLING COMPANY. 2012. Annual Review 2011-2012. Available:http://www.theglassrecyclingcompany.co.za/wp-contentuploads/2014/10/20112012AnnualReview.pdf [Accessed 12/05/2014].

CRAWFORD, M. B. 2006. Shop Class as Soulcraft. The New Atlantis, 13, 7-24.

D'OLIVEIRA, D. 2014a. Glass manufacturer upgrades recycling facility [Online]. Available: http://www.engineeringnews.co.za/print-version/glass-manufacturer-upgrades-recycling-facility-2014-06-06 [Accessed 19/09/2014 2014].

D'OLIVEIRA, D. 2014b. Green Dialogues conference underlines glass-recycling success. Available: http://m.engineeringnews.co.za/article/inaugural-green-dialogues-highlights-glass-recycling-success-2014-06-06 [Accessed 19/09/2014].

DE BEER, R. 2013. Pikitup Johannesburg (Soc) Ltd: Separation at Source Strategic Plan. Johannesburg.

FRAMPTON, K. 1990. Rappel a' l'ordre, the case for the tectonic. In: NESBITT, K. (ed.)

Theorizing a New Agenda for Architecture: An Anthology of Architectural Theory 1965-1995. New York: Princeton Architectural Press.

GAPP ARCHITECTS. 2003. Newtown Cultural Precinct Urban Design Plan. Available: http://www.joburg.org.za/2011/inner_city/newtown/cultural_precinct_udf.pdf [Accessed 04/03/2014].

PFG BUILDING GLASS. 2010. History of PFG [Online]. PFG Building Glass. Available: http://www.pfg.co.za/index.aspx [Accessed 20/06/2014.

GOLDBLATT, M. 2009. Macroeconomic trends, targets and economic instruments. Available: http://wastepolicy.environment.gov.za/sites/default/files/Macroeconomic_trends_targets_economic_instruments.pdf [Accessed 15 April 2014].

HOLL, S. 2006. Parallax, New York, Princeton Architectural Press.

HOOVER, H. C. & HOOVER, L. H. 1950 Georgius Agricola. De Re Metallica., New York, DoverHunter.

HVANTTUM, M. 2004. Gottfried Semper and the problem of Historicism, Cambridge, Cambridge University Press.

JONES, D. 2011. Archaeological Evidencefor Glassworking Guidelines for Best Practice. In: HERITAGE, E. (ed.). London: English Heritage Publishing.

KOCH, N. 2012. Memory and the Wasteland. Master of Architecture (Professional), University of Pretoria.

LANGENHOVEN, B. & DYSSEL, M. 2007. The recycling industry and subsistence waste

collectors: a case study of Mitchell's Plain. URBAN FORUM, 18, 114-132.

LOBELL, J. & KAHN, L. I. 1979. Between silence and light: spirit in the architecture of Louis I. Kahn, Shambhala.

LOWITT, S. 2008. A preliminary analysis of the plastics, paper and glass recycling database: an introduction to the nature and dynamics of the industry. Centre for Poverty, Employment and Growth.

LYNCH, K. 1960. The Image of the City, Harvard U.P.; Oxford U.P.

MARSON, P. n.d. Glass and Glass Manufacture, London, Sir Isaac Pitman & Sons.

CITY OF JOHANNESBURG METROPOLITAN MUNICIPALITY. 2011. Joburg 2040: Growth and Development Strategy. Johannesburg.

NESBITT, K. 1996. Theorizing a New Agenda for Architecture: An Anthology of Architectural Theory 1965-1995, New York, Princeton Architectural Press.

NORBERG-SCHULZ, C. 1976. The Phenomenon of Place. In: NESBITT, K. (ed.) Theorizing a New Agenda for Architecture:: An Anthology of Architectural Theory 1965 - 1995. Princeton: Princeton Architectural Press.

NORBERG-SCHULZ, C. 1980. Meaning in Western Architecture, New York, Rizzoli.

SALAT, S. 2011. Cities and Forms: On Sustainable Urbanism, CSTB Urban Morphology Laboratory.

SALAT, S., BOURDIC, L. & LABBE, F. 2014. Breaking Symmetries and Emerging Scaling Urban Structures: A Morphological Tale of 3 Cities: Paris, New York and Barcelona. International Journal of Architectural Research, 8.

SCHENCK, R. & BLAAUW, F. 2011. The Work and Lives of Street Waste Pickers in Pretoria - A Case Study of Recycling in South Africa's Urban Informal Economy. Urban Forum.

SEAMON, D. 2007. A Lived Hermetic of People an Place: phenomenology and space syntax. Available: http://www.arch.ksu.edu/seamon/spacesyntaxkeynote.htm [Accessed 10/10/2014].

SEAMON, D. 2012. Place Attachment and Phenomenology: The Synergistic Dynamism of Place. Available: http://www.arch.ksu.edu/seamon/Seamon%20Nov%201%20 2012%20final%20draft%20place%20attachment%20chapter%20for%20PDF.pdf [Accessed 10/10/2014].

SEMPER, G., MALLGRAVE, H. F. & HERRMANN, W. 2011. The Four Elements of Architecture and Other Writings, Cambridge University Press.

TAU, M. 2011. Executive Mayor's Foreword. Johannesburg: City of Johannesburg Metropolitan Municipality.

UNWIN, S. 2003. Analysing Architecture, Routledge.

VILJOEN, J. M. M., SCHENCK, C. J. & BLAAUW, P. F. 2012. The role and linkages of buy-back centres in the recycling industry: Pretoria and Bloemfontein (South Africa). Acta Commercii.

LIST OF FIGURES

Note: Unless otherwise stated all images are by author